Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

MARCH 1950

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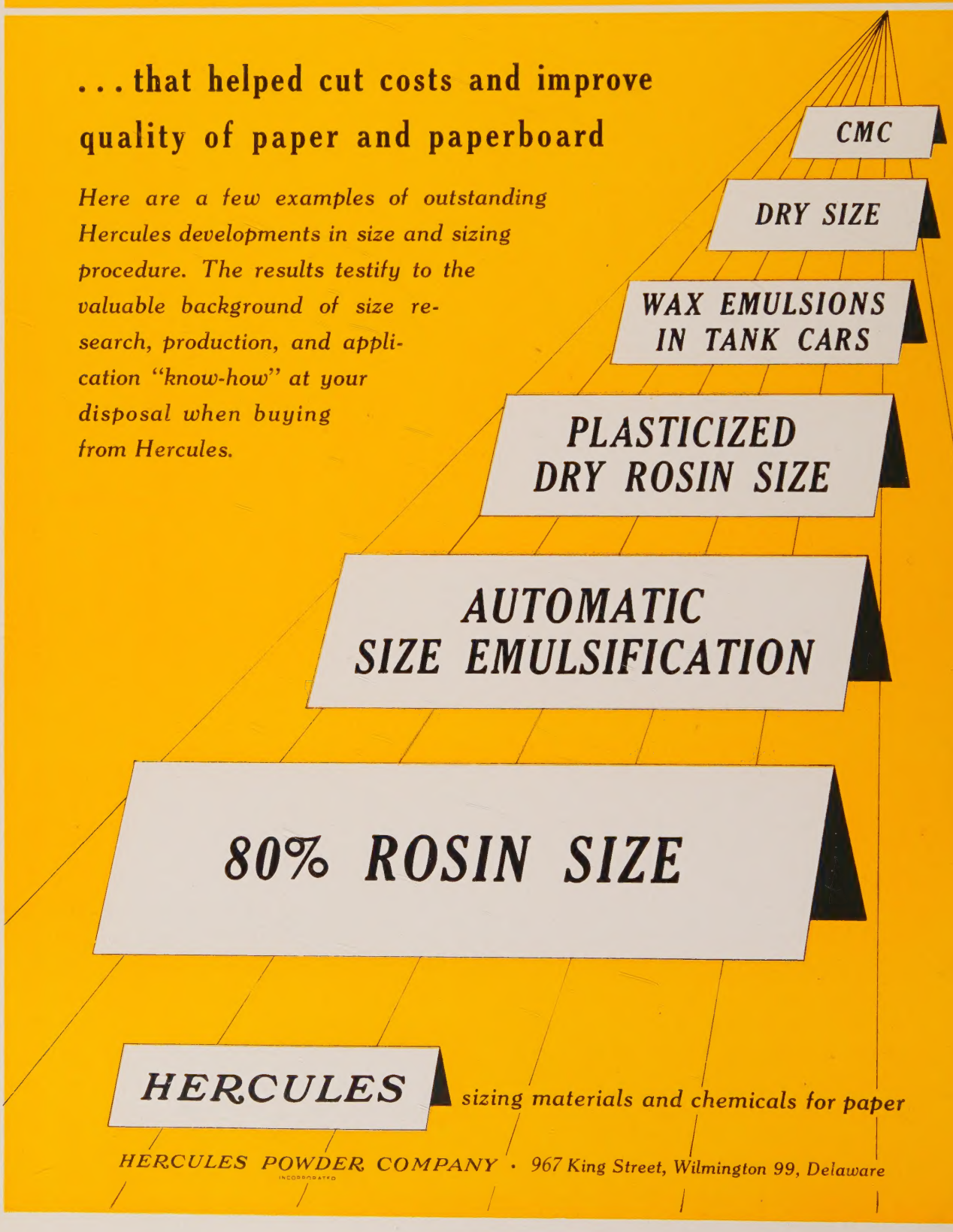

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PP50-2

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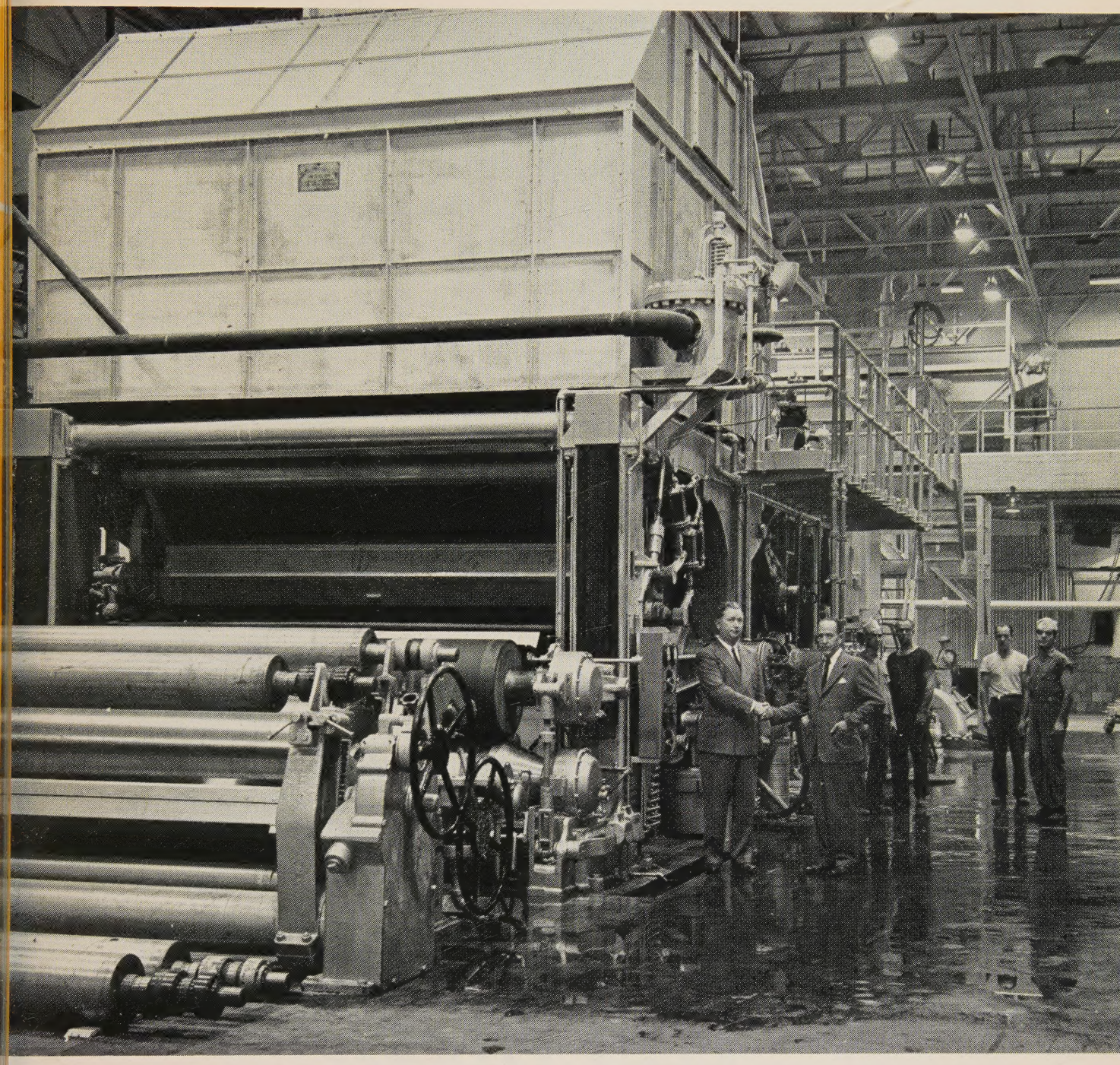

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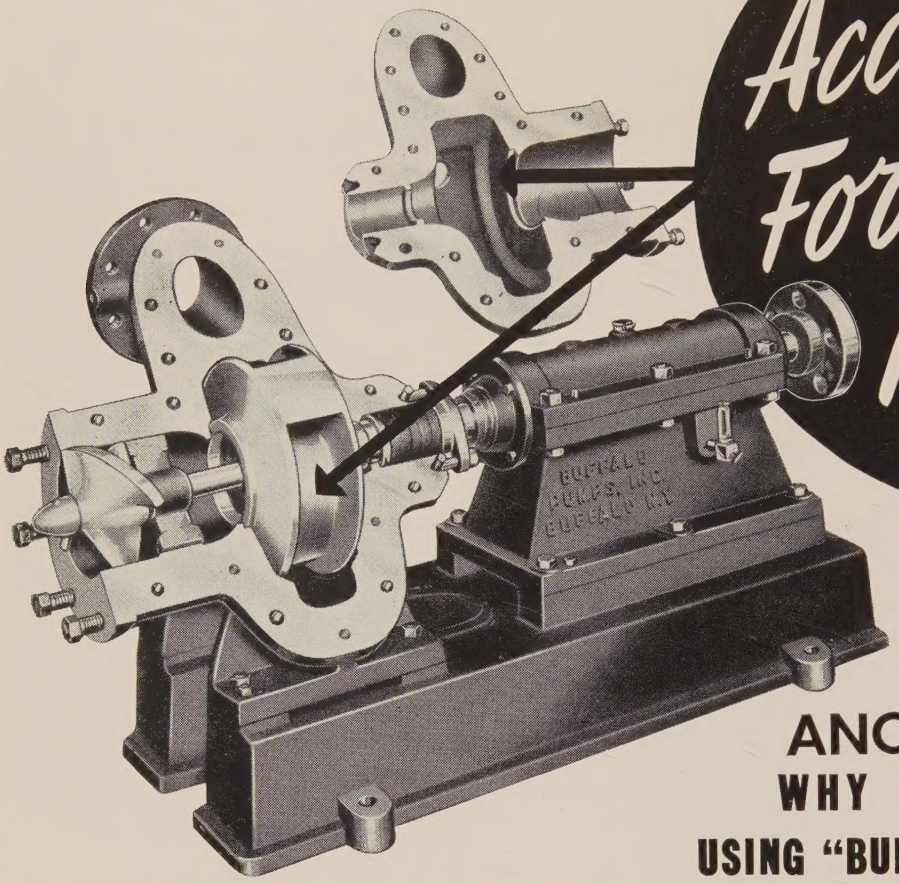

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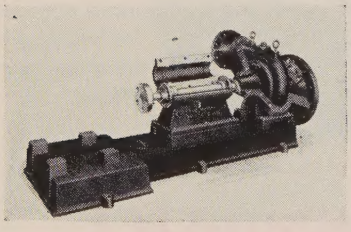

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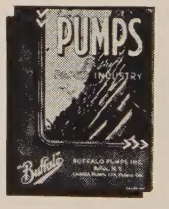

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MARCH 1950

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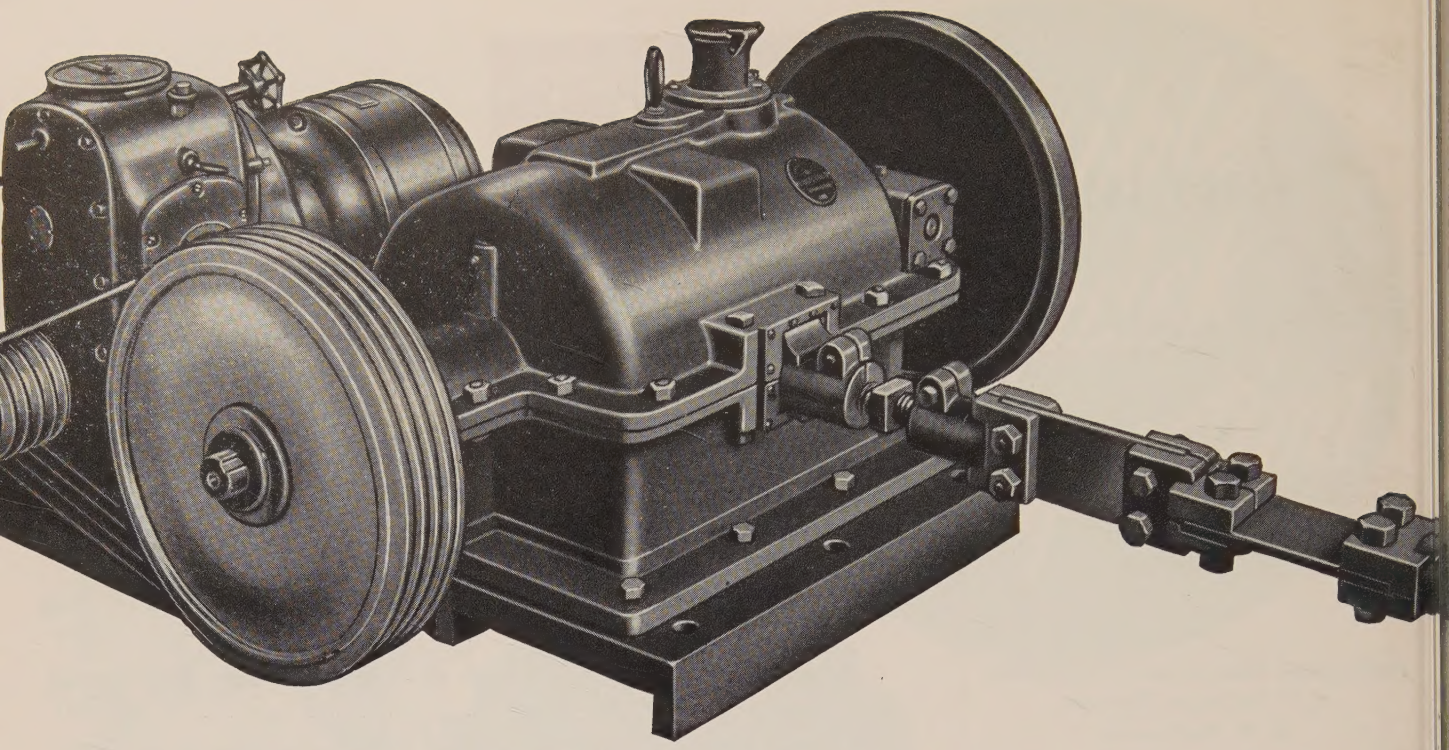

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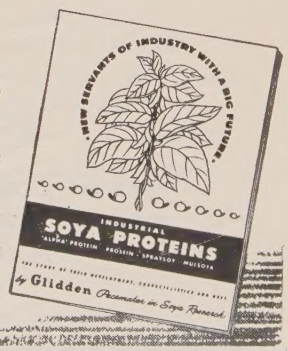

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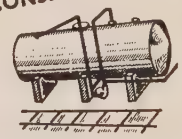

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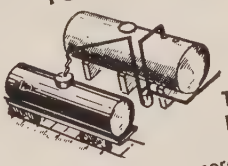

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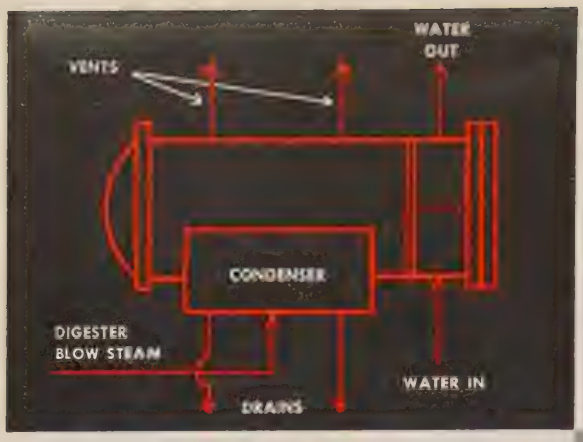

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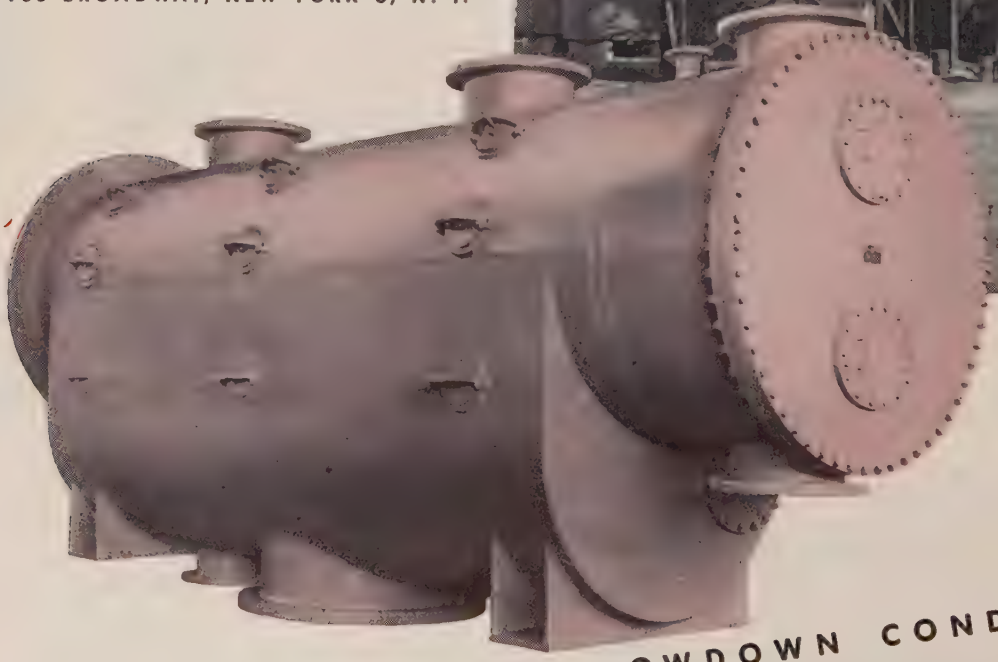

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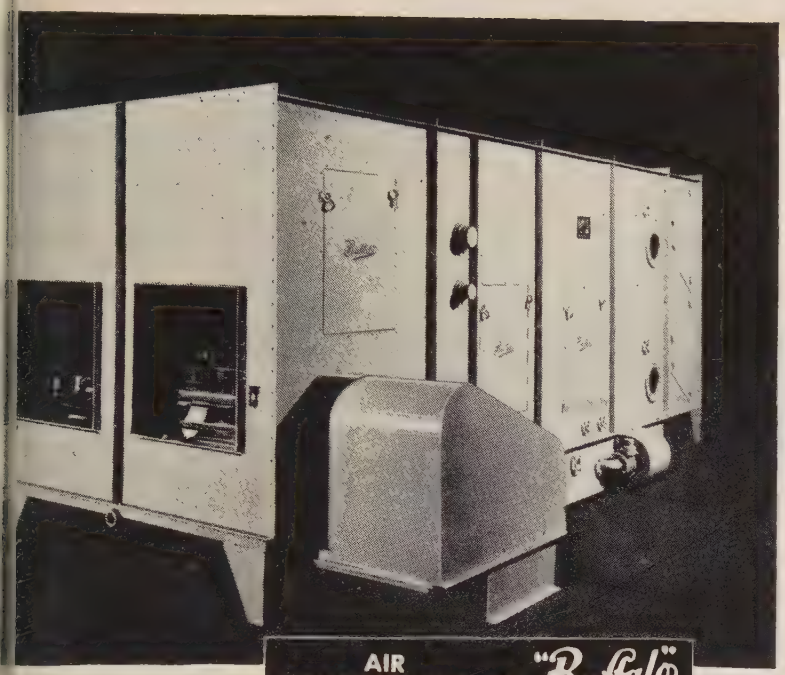

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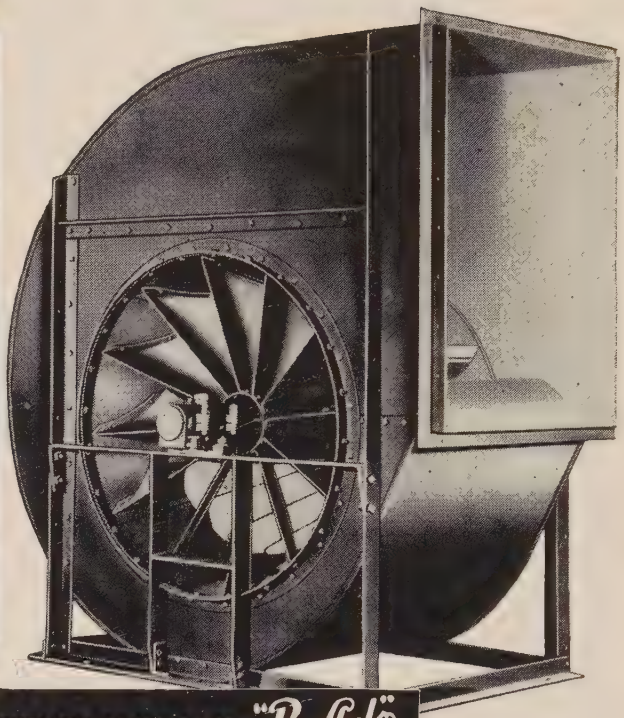

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THE MARSHALL PLAN AND THE EUROPEAN PULP AND PAPER INDUSTRY*

Joseph E. Atchison
(Chief Pulp and Paper Section, Industry Division, Economic Cooperation Administration, Washington, D. C.)

First of all, I want to express my great pleasure at being invited here today, and second, I want to thank the members of TAPPI for the excellent assistance and support which you have given the Economic Cooperation Administration, and the pulp and paper industry of Western Europe.

I consider it a particularly great honor to appear on the same program with George Mead. You know of his great contributions to the pulp and paper industry, but I might add that he has also been one of the greatest supporters of the Marshall Plan and has been serving as a member of Mr. Hoffman's Public Advisory Board since the Marshall Plan began. In a recent speech before the Dayton Council on World Affairs, Mr. Hoffman said in speaking of Mr. Mead, "If America has any better citizen, I for one do not know who it is." I know that all of us here will agree with this sentiment.

Gentlemen, the general purposes of the Marshall Plan are well known to all of you. Its immediate objective was the rehabilitation of Europe—that is, restoring production facilities, stabilizing currencies, halting inflation, facilitating and stimulating trade. By doing these things, to bring order out of chaos, we were certain that the communist menace would be stopped in its tracks.

When we compare the picture today with that of two years ago, there is no doubt that tremendous progress has been made. This first phase of European recovery has been largely accomplished. Furthermore, we have obtained a much clearer understanding of the deeper and more difficult problems which the European nations must solve if recovery is to be lasting and their standard of living is to be increased.

The second part of the job is by far the hardest. Before Europe can become independent of U. S. aid, she must reach a point where her dollar earnings will be in line with her dollar expenditures. To accomplish this, cost of production must be lowered, productivity per man must be improved, new merchandising methods and organizations must be developed, competition must be restored, and new trade patterns must be found.

We are attacking these problems on all fronts. All of our energy is being concentrated on them.

I will tell you more specifically about the problems in the pulp and paper industry of Western Europe and what we are doing about them.

During the first two years of the Marshall Plan the greatest contribution which we made to the pulp and paper industry was in furnishing much-needed raw materials from the Western Hemisphere. Since April 1, 1948, we have allocated $94,500,000 for the purchase of pulp and paper in the United States and Canada. Although this is a comparatively small percentage of the total amount of money which has been allocated, it is, nevertheless, a substantial sum in anybody's language. Perhaps you would be interested in knowing just what was purchased with this money and where these materials went.

This $94,500,000 was spent for the following items:

$40,200,000 or 42.7% was spent for woodpulp for paper
$23,800,000 or 25.8% was spent for dissolving pulp
$19,400,000 or 20.5% was spent for newsprint
$11,000,000 or 11.6% was spent for other paper and paperboard consisting mainly of specialty papers not available in Europe

It can be seen from this breakdown that about 69% of the total was for pulp and the remainder was for grades of paper which were in short supply or not available at all in Europe at the time.

It is quite interesting to note the trend of the requests for allocations of dollars for pulp and paper. It is a definite indication of progress being made toward recovery of Europe's industrial plant.

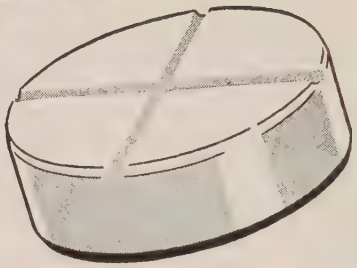
During the first year of operations, total pulp and paper allocations amounted to more than $68,000,000. During the second year, these allocations will total only about $30,000,000 or less than half that of the first year. During the third year, we have estimated that total allocations for pulp and paper will be no greater than $20,000,000.

This is progress, gentlemen. It shows a significant trend toward recovery of the European pulp and paper industry and less dependence upon the United States. Of course, as European production facilities improve, and as the Europeans are able to increase their own dollar earnings by increased sales of their goods in the U. S., these E.C.A. dollar authorizations for purchase of pulp and paper will gradually decrease and will end entirely in June of 1952. This is a natural development. It must be remembered that before the war, Europe was not only self-sufficient in pulp and paper,

(*continued on page 16 A*)

* An address presented at the annual luncheon of the Technical Association of the Pulp and Paper Industry, Hotel Commodore, New York, N. Y. Feb. 23, 1950.

Vanzyme discs



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(*continued from page 14 A*)

but did a tremendous export business in both pulp and finished paper with all the rest of the world.

As the Marshall Plan nears the halfway mark emphasis is switching from allocations for purchase of raw materials to allocations for purchase of capital goods. This ties in with our all-out efforts to increase productivity, improve efficiency, and reduce costs in the industrial plant of Europe. Thus we expect that there will be increased requests for pulp and paper mill machinery as the European mills get their long-delayed modernization and rationalization programs under way. However, none of these requests will be granted unless it can be shown that they tie in with the over-all program. We do not intend to finance equipment for any plant which must depend upon protective tariffs and trade restrictions for its survival. We want modern plants which can fit into an integrated economy of all of Western Europe with rapid elimination of trade barriers.

In speaking of the part that the pulp and paper industry is playing in the Marshall Plan, I want to make it very clear that we in E.C.A. do not lay down a set program for the pulp and paper industry of Europe. Just as in all other industries, the Europeans make up their own program and run their own show. In the over-all program the United States is only putting up 3% of the funds going into capital improvement and expansion in Europe, as compared with Europe's 97%. Just as bankers, we advise, suggest, help in any way possible, and in certain instances withhold money for materials that appear to be unneeded for the recovery program. But as good bankers, we do not try to run the business.

In order for us to know what is needed to be done in the pulp and paper industry in Europe, we felt that we had to have some on-the-spot information. Consequently, I was sent over to Europe last year to make a study of the situation in several of the countries. These studies are being continued by experts from our Paris office so that we keep in constant touch with what is going on in the industry.

I would like to tell you about some of the things I learned in Europe because I feel that what I saw over there is intensely interesting to many of you. I covered seven countries over a period of five months, and made a great number of visits in each country. Because I was with the Marshall Plan and had the backing of every government, every door was open to me and the managers and technicians talked to me without reservation or reserve. After this trip, I was more convinced than ever that to get a true picture of conditions in any country an on-the-spot inspection is necessary.

It is surprising how few people, outside the industry, realize the importance of the pulp and paper industry in Western Europe. It is the leading industry in several of the Marshall Plan countries and occupies a key position in all of them. Although the industry has no tremendous and spectacular plants such as the steel, petroleum, and automobile industries, it consists of hundreds of small mills which nevertheless have a far-reaching effect upon the economies of the various countries. In some of the countries it is the leading export industry and its products play an extremely important role in intra-European trade. In addition, woodpulp is one of the biggest dollar earners among Europe's exports.

In all of Western Europe, the industry is capable of turning out about 6 million tons of pulp and over 8 million tons of paper and paperboard, with a total value of over $2 billion annually. It employs over 400,000 workers. It has been estimated that if the entire physical plant were to be replaced at current prices, it would cost over $3 billion.

In an industry of this size, you can well understand the need for a sizeable investment program. If we were to take 25 years as the average lifetime of pulp and paper mill equipment under competitive conditions, it would require approximately $80,000,000 worth of machinery and equipment per year to merely keep the European plant up-to-date. This would be assuming that the present plant is modern and can produce competitively. This is not the case by any means.

The truth is that very little new equipment has been installed in most of Western Europe in the last ten years. In addition, much destruction occurred during the war. Add to this fact that a great proportion of mills were obsolete in comparison to our standards even before the war, and the need for investment capital reaches staggering proportions far beyond the $80,000,000 annually needed for mere normal replacements. An annual investment of $150,000,000 would be much more realistic in view of the need.

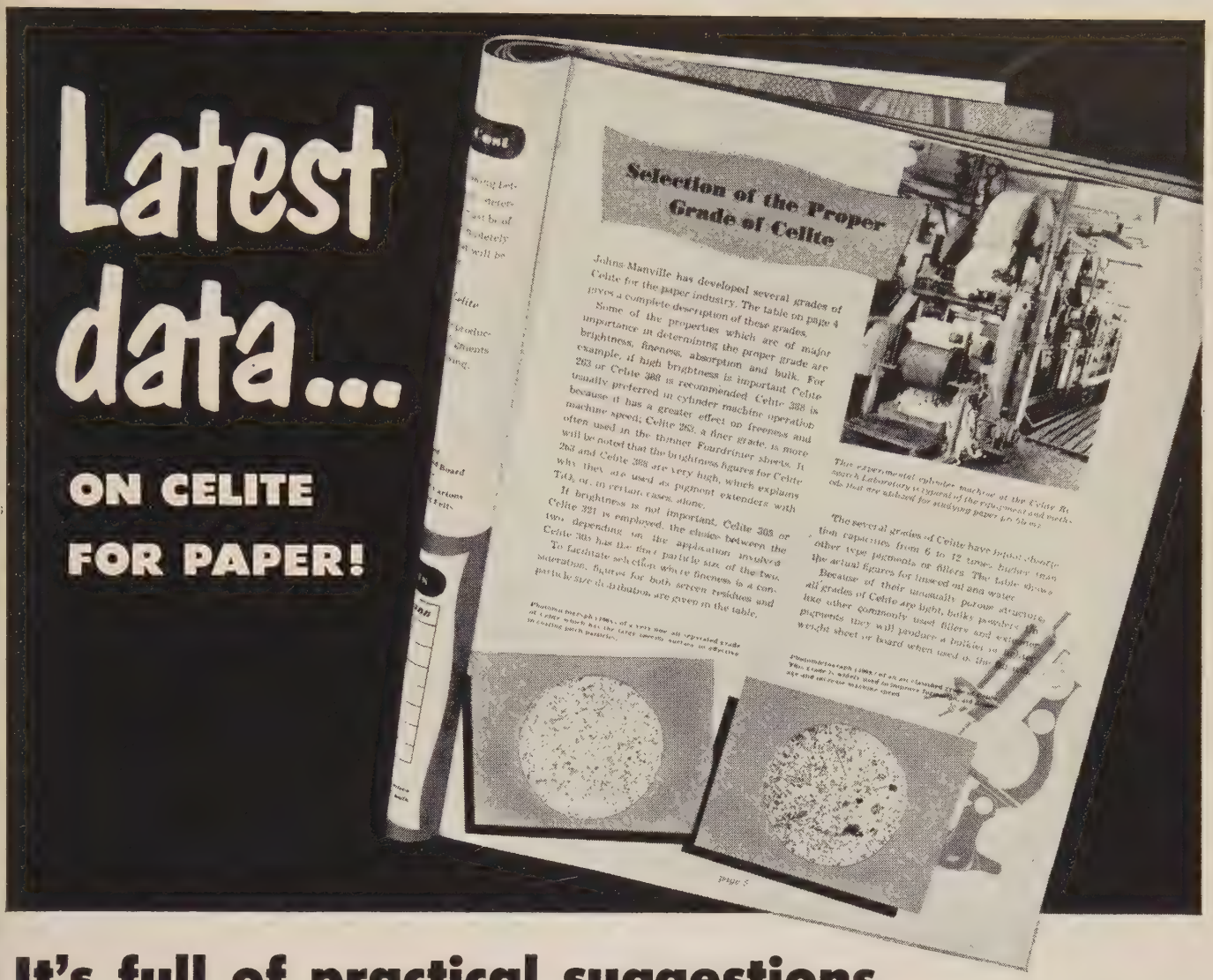
What is actually happening in the investment field? The investment program for the entire year of 1948 for all of Western Europe's pulp and paper industry amounted to only $37,000,000. Of this amount, about $2,000,000 worth of equipment was purchased with dollars—all in the United States. During fiscal year 1949/50 the total investment program is expected to be about $75,000,000 of which $12,000,000 will be spent in the United States. It is easily seen that this program is pitifully low in comparison to the need.

At least the trend is up, and there are ever greater signs that European industry is waking up to the hard facts of life regarding the necessity for constant investment back into their factories. We do not know yet what the total investment program will be for 1950/51, but we have indications that it will be greater than the present rate and actually may show a realistic relationship to the need.

During my travels in Europe, I was particularly interested in the developments in the use of straw for pulp and paper. Although numerous reports had appeared in American publications, none of these really had described the European developments in this field to an adequate degree. I found that the technology for production of both unbleached and bleached pulp from straw had reached a high state of development in more than one of the European countries.

In Italy, the use of straw for the manufacture of bleached pulp and paper had reached a higher state of development before the war than in any other country of the world. This development received great impetus under Mussolini's program of self-sufficiency during which time several modern bleached straw pulp mills were constructed with government assistance. I saw high-quality bleached straw pulp being made in Italy by three different processes on a commercial scale.

(*continued on page 18 A*)



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(*continued from page 16 A*)

This pulp was being used in many grades of paper—including newsprint which we have heard so much about recently.

But Italy is not the only country in which straw is being used. I saw bleached straw pulp being used in fine grades of paper in Germany. I saw large-scale production of strawboard of many grades in the Netherlands. In England, I saw a pilot plant producing continuously two tons of bleached straw pulp per day for use in an adjoining fine paper mill, and I saw commercial production of both strawboard and bleached straw pulp.

In addition, I saw on the drawing boards many new plans for construction of bleached straw pulp mills all over Western Europe. In view of the great shortage of pulpwood there, this is a significant and important development. We are encouraging it in every way possible.

While I was in Italy, I had a rare opportunity to witness a specific example of how the Marshall Plan affects not only the industrial plant of a nation, but how it affects the very political climate itself. While in Rome, I was invited by the Chief of the Industry Division of our E.C.A. Mission to Italy, to accompany him to a ceremony in connection with the opening of a railroad line in the Apennines Mountains.

This was no ordinary railroad opening. It was in the heart of an area which had a strong communist party following—the line connecting Bologna with Florence across the Apennines through Pistoia. This railroad, although very short was extremely important to the people in this area, being practically their only means of transportation out of these rugged mountains. This particular section of the line had been closed to traffic since the retreating German armies had destroyed 24 tunnels, 6 large bridges across 200 foot canyons, and about 20 miles of track. Its reconstruction involved 650,000 man-days of work and an expenditure of more than $2,000,000. About two thirds of this amount had come from Marshall Plan counterpart funds.

Our party boarded the private train of the Italian Minister of Transportation early on Sunday morning at the beginning of the line. We found that practically all of the high government officials were on the train, so we soon realized that this must be an event of great importance. As we approached the first town along the line we could hear loud cheering in the distance. We soon saw that the entire populace of the small town had turned out to show their appreciation for this great event in their lives. As the train stopped, large bouquets of flowers in great quantities were brought aboard, the Mayor of the town greeted us, the priest of the town repeated a blessing, and the crowd cheered as only Italians can. We accompanied the Minister off the train and down the line of happy people. There we saw large posters everywhere pointing out that this project had been made possible with the help of Marshall Plan funds.

As we went from town to town, on our journey to Pistoia, the same reception was repeated. It was truly one of the most heartwarming experiences I have ever been through. Make no mistake about it, those people knew who their friends were. The communists had been spreading their usual lies in trying to convince the people that the Marshall Plan was only for the big businessman and that it would never help them, and that the government was not interested in their problems. But this railroad was tangible evidence that they had not been forsaken even though they were only a small segment of the population. It had a tremendous effect upon their political thinking.

Upon arrival at Pistoia, the Minister of Transportation gave a rousing speech before the thousands of people gathered in the city square. I shall never forget the tremendous ovation which he received at the completion of his speech. We were all very proud that we were participating in the plan which made this vital project possible.

Another field in which I was particularly interested during my trip, was the developments in the use of hardwoods such as poplar and beech. There, too, I found some very interesting things. Just as in developments in straw pulping, Italy has been the leader in Europe in the use of hardwoods.

Almost all of the mechanical pulp produced in Italy is made from poplar, and practically all of their newsprint is made with this poplar groundwood. For the past 20 years, Italy has been cultivating poplar as a crop. This also received impetus under Mussolini's self-sufficiency program. Many of the peasants have found that they can make more money by growing poplar than by growing annual crops—and with much less work. I also saw excellent quality dissolving pulp being produced from beech in Italy.

In other countries, the use of hardwoods has not reached nearly so high a state of development as in the United States. However, I had constant inquiries regarding the extensive use of hardwoods in the United States, and I am certain that there will be many developments in this field in Europe in the future. Now that other countries are aware of the great success which Italy has had in large-scale cultivation of poplar, they are all investigating this possibility. This promises to be a very significant development and may well become of tremendous importance to the European pulp and paper industry. We are encouraging this development in every way possible.

Many of you may be wondering what has happened to the pulp and paper industry of Germany which at one time was the world leader in this industry. Of course, a great part of their former industry is now behind the iron curtain so I can't report on that. However, I did visit many of the mills in Western Germany and talked to many of the leaders in the industry. The thing that impressed me most was the depressing effect which a ruthless dictatorship can have upon every segment of the life of a country. I was told that from 1933 on, no German pulp or paper mill was allowed to install a single piece of new equipment or do any modernization work unless it contributed directly to building up the war potential. As a result, today the German mills are almost hopelessly obsolete, their production methods are antiquated, and the quality of many of their pulp and paper products is far below the quality of products from Scandinavia and the Western Hemisphere.

Going from a position of world leadership in the pulp

(*continued on page 20 A*)

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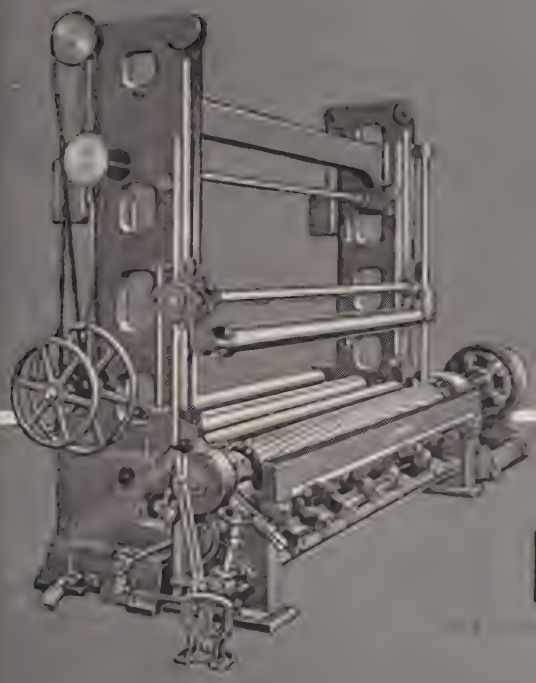


SLITTERS

Langston

ROLL WINDERS

(*continued from page 18 A*)

and paper industry down to their present position is a real tragedy.

It is not possible to make many generalizations about the pulp and paper industry of Europe as a whole. However, there are a great number of problems confronting the industry. As I see it almost all of these problems can be solved by two basic things. Those are *investment* and *cooperation*. I think that one of the most important things which has happened during the past two years is that the Europeans themselves have begun to realize that these problems do exist. They also realize that they will have to attack these problems by investment and cooperation if they are to survive.

I have mentioned the investment program, how inadequate it has been in the past and the improved prospects for the future. I'll mention some of the specific projects which E.C.A. has helped to finance and some which are in the cards for the future.

One of the most important of the projects financed to date involved an expenditure of $950,000 for purchase of stock preparation equipment and a new modern fourdrinier machine for production of glassine and other grades of paper from bleached straw pulp in Italy. One of the most important features of this project is that it will provide for the introduction of the first really modern paper machine into southern Italy. By watching it in operation, other mill executives might see the tremendous value of modernizing their own machines to take advantage of improvements which have taken place over the past 30 years. A few modern machines such as this scattered over Italy could well result in a revolution in paper mill production techniques.

Another project involved expenditure of $1,650,000 for the first modern high-speed newsprint machine in Italy. It is to have a top speed of 1300 feet per minute as compared to present top speeds of 600 feet per minute. The company, Cartiere Burgo, expects to use poplar entirely as a source of fibrous raw material for this machine. They will combine poplar groundwood pulp with poplar semichemical pulp. Thus no new requirements for softwood will be involved and the production of much-needed newsprint will be increased by 30,000 tons per year.

Two interesting projects in prospect for the future involve construction of two completely integrated kraft pulp and paper mills. One of these is projected in Portugal and one in Austria and each is expected to have a capacity of 100 tons per day. Although much of the expenditure for these mills will be in Europe where their own European currencies can be used, there will be a considerable amount of equipment which they will both have to purchase in the United States. Portugal and Austria are two of the very few countries in Western Europe which have sufficient supplies of softwood pulpwood to allow any additional expansion of their pulp production facilities. Since pulpwood is in such short supply any sound development along this line is being encouraged.

Now you might ask what effect all of these new European developments will have on the U. S. pulp and paper industry. It's difficult to say, but I certainly don't anticipate any startling effect. In view of the great need for increased consumption of paper in Europe, I do not foresee any appreciable increase in volume of exports of pulp and paper from Europe to the U. S.

At the present time annual consumption of paper in Europe varies greatly from country to country, being as low as 5 pounds per capita in Greece and as high as 130 pounts per capita in Sweden, the average for Europe being 56 pounds per capita. This is in contrast to 360 pounds per capita consumed in the United States. Furthermore, total consumption of paper and paperboard in the U. S. increased by 94% between 1938 and 1948 whereas the consumption in Europe is still below prewar levels. The Europeans hope to raise consumption from 56 pounds per capita per year at present to 66 pounds by 1952. Even this small increase of 10 pounds each for 270,000,000 people would require an increase of 1,350,000 tons.

In view of this anticipated increase in consumption in Europe it is difficult to see how the increases in exports to the U. S. could be more than a mere trickle.

In fact, if the present low rate of paper consumption in Europe is to be increased by even 10 pounds per capita, additional sources of fibrous raw materials must be found and exploited, and investment capital far beyond that available in Europe must be found.

This problem of investment is a very serious one in Europe. There is so very little capital available for new investment yet there is such a great need for it.

All over Europe I saw tremendous opportunities for investment in the pulp and paper industry. In fact, as I traveled through Europe I could not help but think of what wonderful opportunities there were for investment of private American capital and American know-how. This certainly is one of the methods of closing the dollar gap and at the same time could be very profitable to many American companies with their new techniques, new products, and progressive marketing methods. Many of the leaders in the European industry indicated great enthusiasm about the possibility of such investments and said that they would welcome the cooperation of American industry on an individual basis. This was particularly true in Germany where new investment capital is so badly needed, and where so many opportunities exist.

Of course, many obstacles only too readily come to mind regarding such investments, such as political instability, difficulties in converting profits and capital back to dollars, the threat of nationalization of industries, etc. Such conditions have suggested the need for government aid in bringing about the conditions necessary to encourage movement of American capital abroad. A start is being made in this direction.

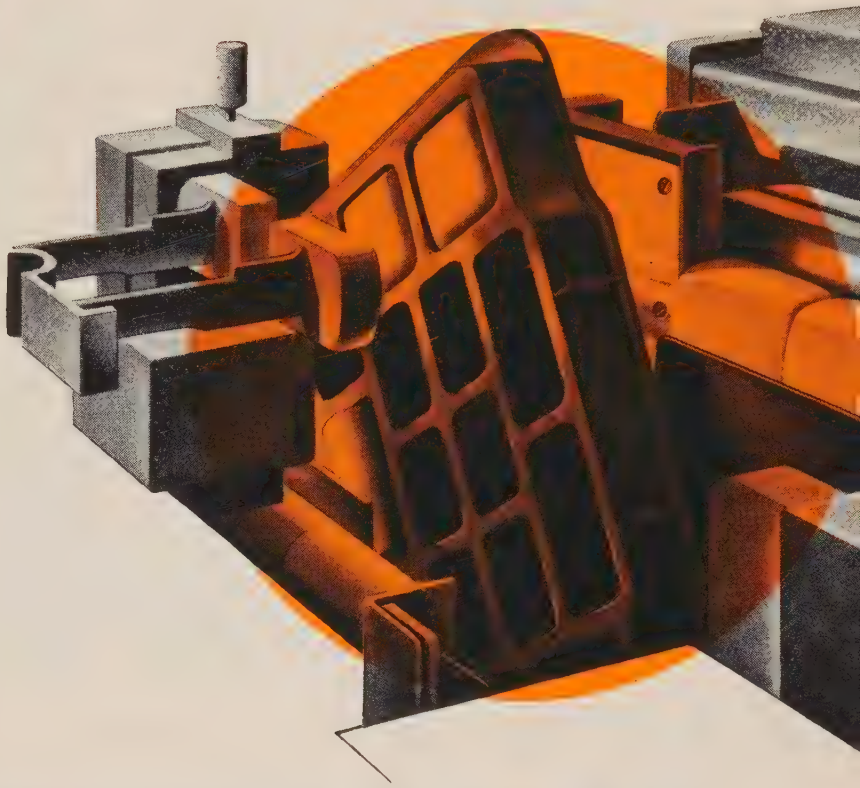
E.C.A. has a program of investment guaranties which provides for convertibility of currency. Moreover, there is before the Congress a bill to authorize the Export-Import Bank to make guaranties to Americans who make new private investment abroad against the risks peculiar to foreign investments. Private investments abroad *are* becoming much safer.

As important as the investment problem is, I think that on a long-range basis this matter of cooperation in the pulp and paper industry of Western Europe is even more important—and by that I don't mean cooperation

(*concluded on page 22 A*)

as you were in 1900

Many soap-making operations were done by hand;
so were some of the processes involved in paper,
textile and glass manufacturing as well as water
purification and sewage treatment.



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in the form of cartels, production quotas, and price setting.

Most important on the broad front is the complete economic integration of Western Europe with a single market of 270 million consumers. Then instead of each country having great numbers of small high-cost mills limited to domestic markets by protective barriers on the part of its neighbors and protected from foreign competition by its own trade barriers, an atmosphere would be created for development of large-scale, low-cost production mills which are so common in the United States. Greater specialization and standardization of grades would result and this would automatically bring down costs and increase productivity per man.

Just try to imagine what the status of the pulp and paper industry in the United States would be today if each of the 48 states had protective tariffs against imports from its neighbors.

Cooperation within the European pulp and paper industry, however, does not have to wait for complete economic integration of Europe. It is starting right now, and we are doing everything possible to promote it.

In America, the pulp and paper companies for years have exchanged technical knowledge. We hold these great national conventions in which we tell each other about new methods, new techniques, and new products which have been developed. Everybody gains by this exchange. But in most countries of Europe, there are few such meetings. This secretiveness and absolute refusal to cooperate with each other in exchange of information on technical knowledge, production data, labor statistics, marketing methods, and other things has been one of the principal obstacles in the way of progress in Europe. Steps are being taken to change that attitude.

One of the most tangible activities in our efforts to bring about cooperation and thereby increased productivity is our technical assistance program. Under this program we bring teams of European technical men, labor relations men, market promotion men, and mill managers to this country to let them see for themselves our plants in operation and our cooperative spirit at work. Many engineers who have visited American mills have been delighted, but completely amazed, at the freeness of exchange of information and the great degree of cooperation among American mills. They have gone home determined to bring about changes in their own industry.

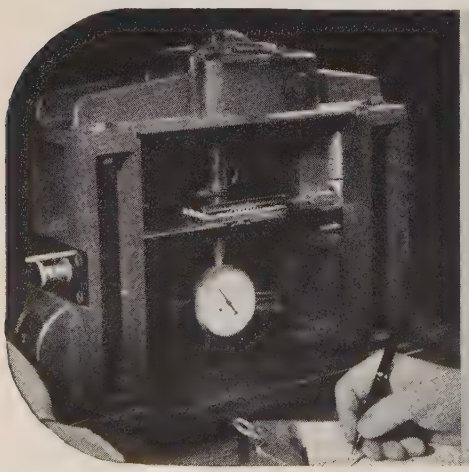
I am very happy that we are able to have with us here at this convention the first European pulp and paper team to visit the United States under this technical assistance program. I know that many of you have met and talked to members of this team and know what a fine group they are. The team is composed of 33 members representing 12 different European countries. Their special fields vary greatly and include pulp and paper machinery production, pulp manufacture, paper and board manufacture, converting and marketing, trade association activities, and labor-management relationships. All of these men have been chosen carefully and are outstanding men in their respective fields.

They have come prepared to do a job. During the next eight weeks they will visit a great number of pulp and paper mills, research and development laboratories, converting plants, and machinery companies. They will see for themselves what management and labor alike gain from greater cooperation and greater productivity.

They will learn about new processes, new methods of operation, new machinery and equipment, new product developments, market promotion methods, trade and technical association structure, and labor-management relationships. Then when they return to Paris, they will prepare a report of their findings. This report will be distributed to all of the Marshall Plan Countries. Team members will follow through and see that their recommendations to the industry are carried out. We know that great improvements will be made.

As members of this European Technical Assistance Team have attended sessions of this great convention I know that they have been wondering why they cannot have such an organization in Europe. I think that one of the greatest contributions which the Marshall Plan might make in our field would be to promote the establishment of a Technical Association of the Pulp and Paper Industry of all of Western Europe. One has only to think of the outstanding contributions which TAPPI has made to the pulp and paper industry of the United States to visualize the possibilities of a similar organization covering the entire industry of Western Europe with its 270,000,000 people.

It is only by such all-out cooperative efforts that the pulp and paper industry, one of the largest and most vital of European industries, can move forward and play its proper role in the over-all European Recovery Program.



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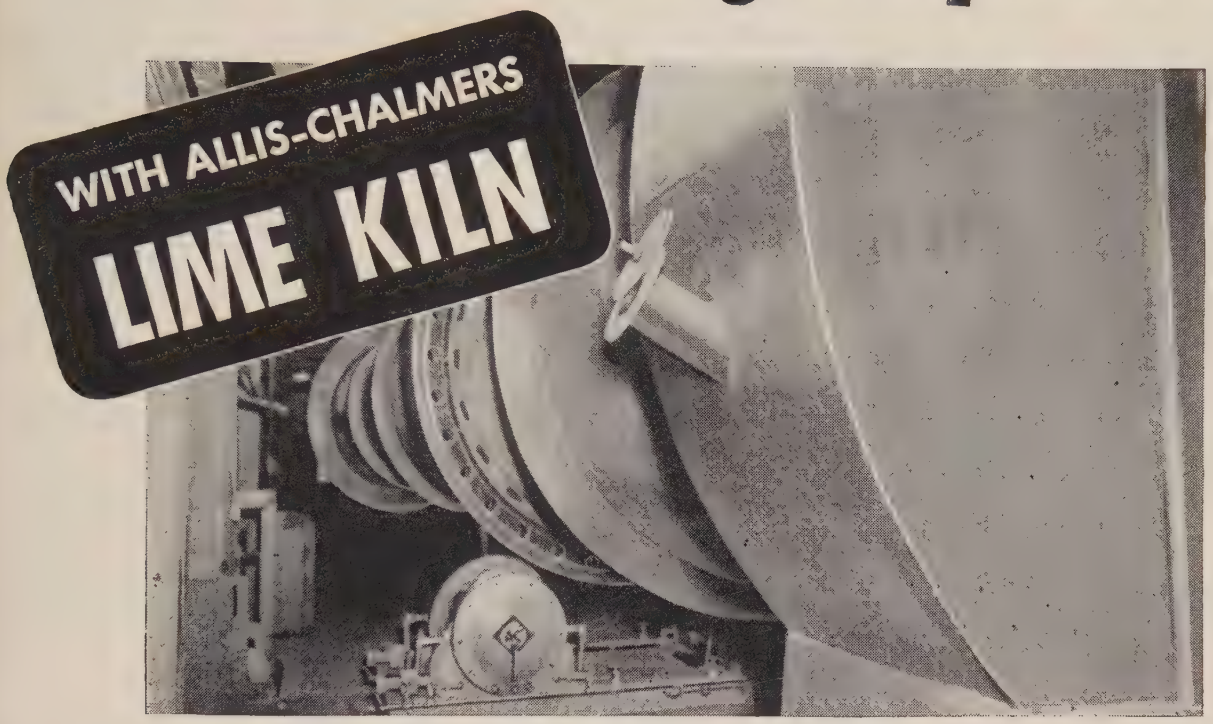

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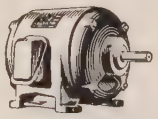
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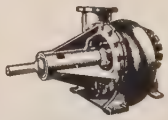
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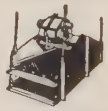
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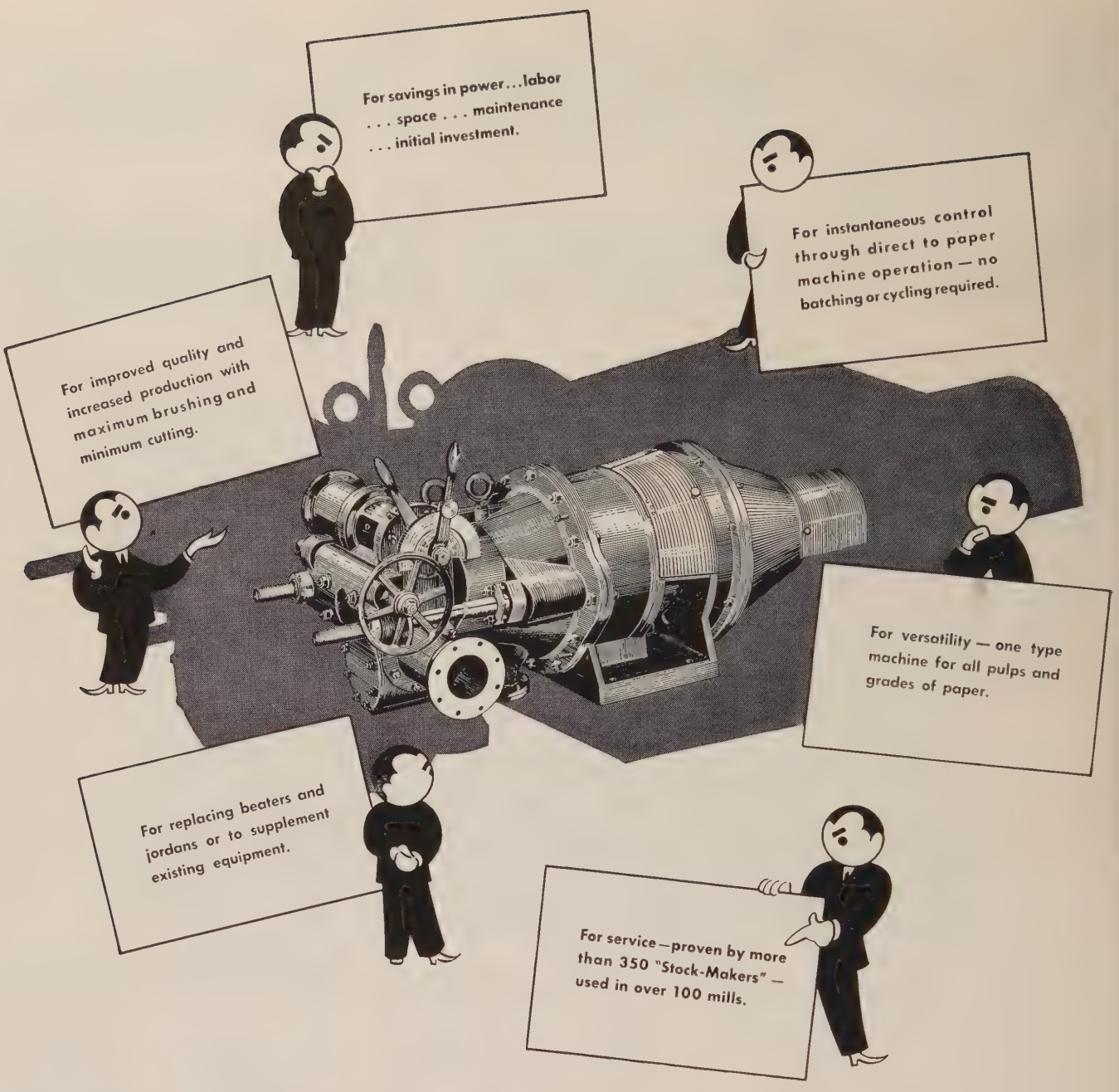
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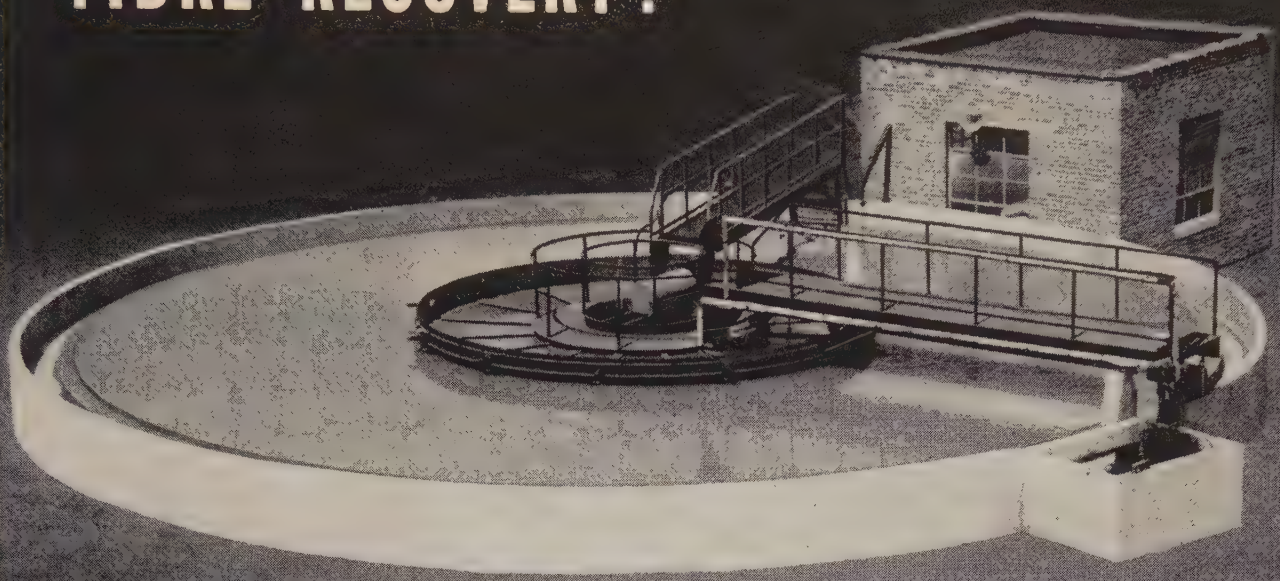

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Here's what we've done at the River Raisin Paper Company plant in Monroe, Michigan. A CYCLATOR is treating white water from two cylinder machines producing liner board. B.O.D. reduction averages 52.4%!* Suspended solids are reduced 99.0%!* In addition to these positive stream pollution abatement steps, fibre losses have been reduced to 0.1%* by reusing the underflow which has a consistency as high as 2.5%.* The value of the recovered fibres defrays a high percentage of the operating costs. If white water, stream pollution abatement and fibre recovery are among *your* problems, put them up to INFILCO! Send today for our Bulletins No. W850, 23-409, and other pertinent data.

A FEW INFILCO WHITE WATER TREATMENT PLANTS

CAROLINA PAPER BOARD CO.	Charlotte, N. C.
CONTINENTAL DIAMOND FIBRE CO.	Bridgeport, Pa.
FEDERAL PAPER BOARD CO.	Reading, Pa.
W. C. HAMILTON & SONS CO.	Miquon, Pa.
NEW YORK & PENNSYLVANIA CO.	Johnsonburg, Pa.
RIVER RAISIN PAPER CO.	Monroe, Mich.
TAYLOR FIBRE CO.	Betzwood, Pa.
AMERICAN DEFIBRATOR CO.	Mexico City, Mex.

**Michigan Stream Control Commission Report, March, 1949*

INFILCO

• BETTER WATER CONDITIONING AND WASTE TREATMENT SINCE 1894 •

INFILCO INC.

GENERAL OFFICES: 325 WEST 25th PLACE • CHICAGO 16, ILLINOIS

SALES OFFICES IN TWENTY SIX PRINCIPAL CITIES

WORLD'S LEADING MANUFACTURERS OF WATER CONDITIONING AND WASTE TREATING EQUIPMENT

STEBBINS

at

COOSA RIVER NEWSPRINT COMPANY

The Stebbins installation of tile tanks and tile linings is the largest of its kind ever made in the pulp and paper industry.

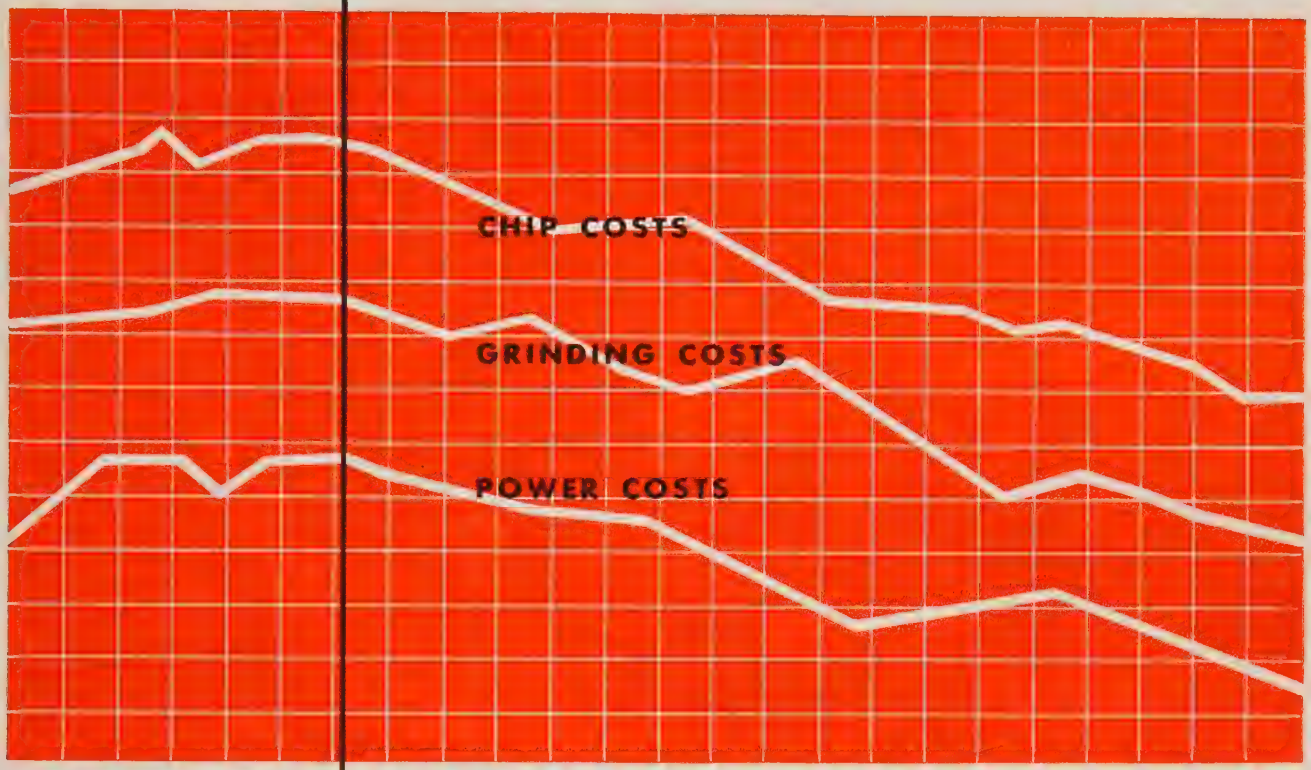
The installation includes the erection of all tile tanks and stock chests in the mill, as well as the lining of all concrete tanks, bleach towers, wire and couch pits and other stock handling equipment which requires tile lining.

SEMCO

Stebbins Engineering and Manufacturing Company

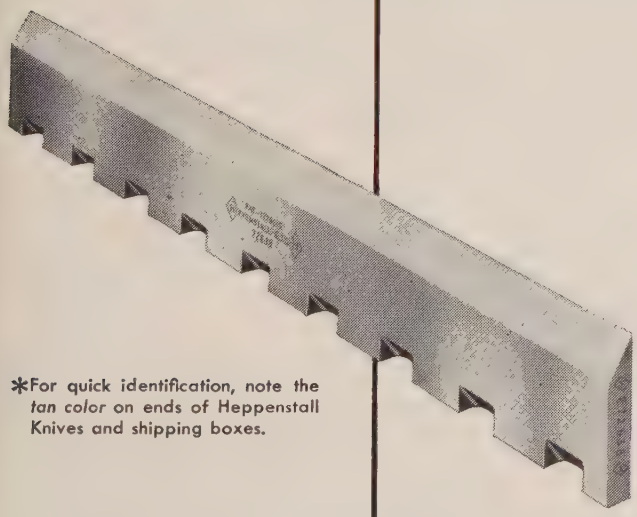
359 EASTERN BOULEVARD, WATERTOWN, NEW YORK

pointing the way...
to lower production costs



HEPPENSTALL

E.I.S. Chipper Knives



*For quick identification, note the *tan* color on ends of Heppenstall Knives and shipping boxes.

Production costs take a tumble when you equip your chipper with Heppenstall E.I.S. Knives—and there are sound reasons why! These solid alloy steel knives hold their keen edges during long runs, insuring a higher yield of uniform chips . . . fewer oversized or bruised chips . . . less sawdust waste. You save on chipping costs—and get better quality pulp at the same time.

Because they do not dull readily, Heppenstall E.I.S. Knives require less grinding. This means fewer shut-downs for re-grinding! And with less steel removed from the blade, the result is longer knife life.

Add to these advantages a steady savings in power costs, due to the clean-cutting qualities of these superior knives, and you can see why they are the choice of leading mills throughout the country. Why not profit from the experience of others and order your Heppenstall E.I.S. Chipper Knives today?

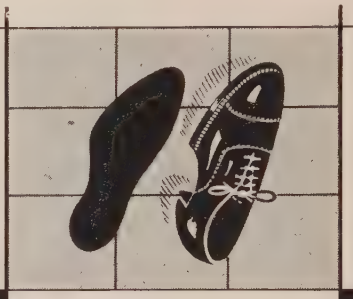
HEPPENSTALL COMPANY
PITTSBURGH 1, PA.

Jobs for WALDRON machines

The surprisingly wide variety of manufacturing operations being performed with WALDRON machines and equipment clearly indicates the extent of WALDRON service to industry. The manufacturing operations mentioned below represent twelve of the many different processing jobs for which WALDRON equipment was specified during a period of one year only. If its a problem of converting, its a job for WALDRON machines.

Applying backing paint to rug material. Many other coating applications.

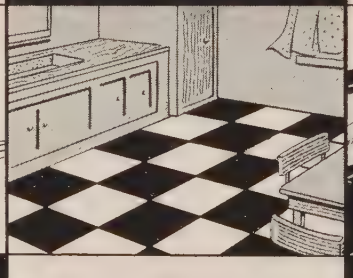
Applying ground coat to wall paper.



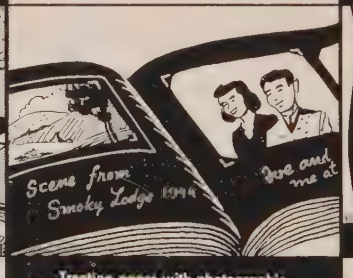
Coating material used for innersoles.

Multi-color printing of cotton piece goods.

Rotogravure printing of decorative papers.



Flat Block printing of linoleum.



Treating paper with photographic emulsions.

Festoon drying of wide web goods.

Impregnating material used for making gaskets.

Embossing glassine used for bag stock.

Embossing design on labels.

Applying required sizing to playing card stock.

Coating Machines
Creping Machines
Embossing Machines
Floor Cov. Machines
Gumming Machines
Laminating Machines
Printing Machines
Rubber Mill Machines
Wall Paper Machines
Waxing Machines
Winders and Slitters
Special Design Machines

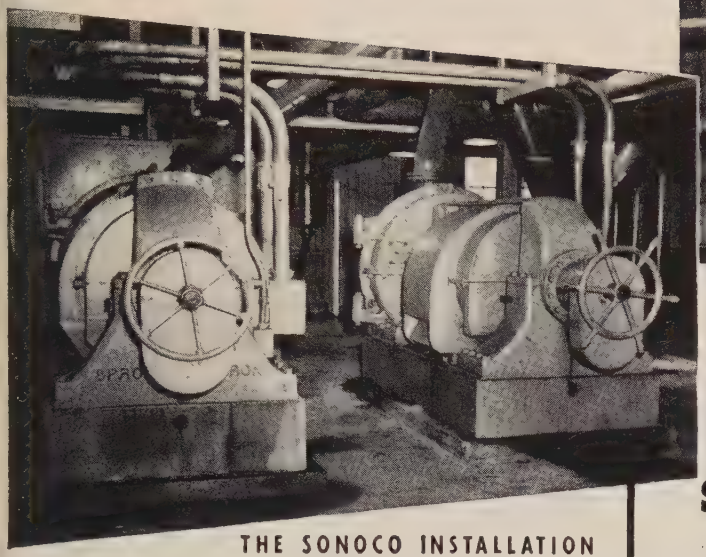
JOHN WALDRON CORP.

Main Office & Works: NEW BRUNSWICK, NEW JERSEY

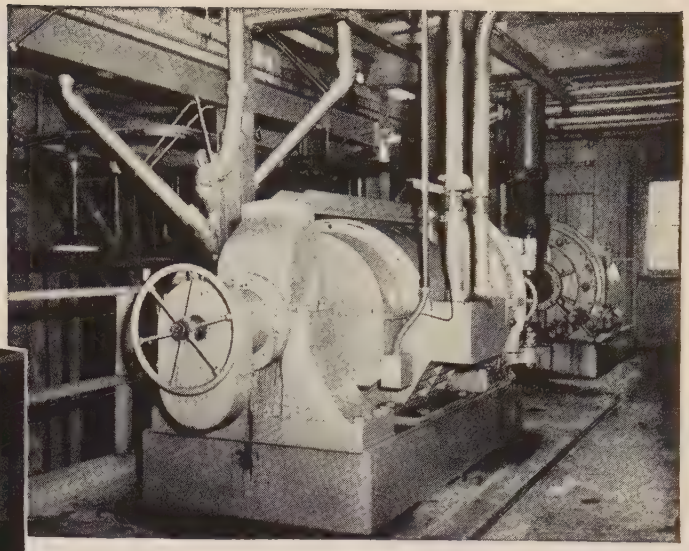
BUILDERS OF QUALITY MACHINES SINCE 1827

Mills that compare

Refiners



THE SONOCO INSTALLATION
Hartsville, S. C.
Showing Sprout-Waldron Refiners for Semi-Chemical Pulping



choose

Sprout-Waldron

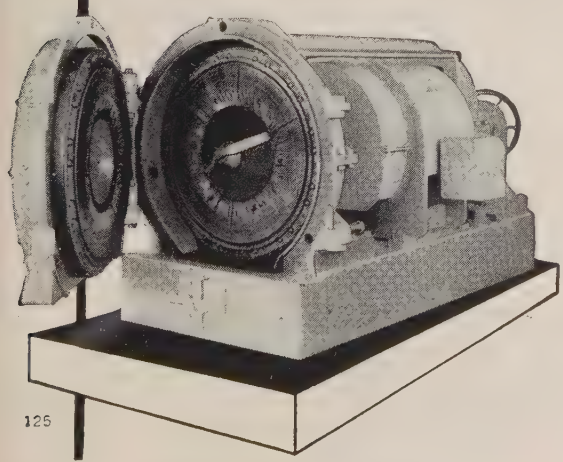
The many recent installations of Sprout-Waldron Refiners for semi-chemical pulping prove—that **Sprout-Waldron Refiners are definitely preferred for this type of operation**

But these rugged, precision engineered Refiners can do **any** kind of pulping—do it well and with great economy. Their exclusive peripheral control ring feature provides great flexibility of adjustment, so that you can produce a wide variety of pulp characteristics. With the S/W Refiner you can pinpoint exact pulp requirements.

Initial investment is comparatively low, and inexpensive long-life plates are available in many styles. High production rates; economy in power consumption; ease of operation, adjustment, and maintenance give you other important advantages.

Our representative will be glad to explain how Sprout-Waldron Refiners can increase your output and save operating costs . . . or let us send you our Bulletin R-748. Address Sprout, Waldron & Co., Inc., 38 Waldron Street, Muncy, Penna.

S/W Refiners do a wide variety of jobs—all of them thoroughly and economically. Here are some applications: refining kraft, soda, and sulphite knotter and fine screen rejects; hogged bull screen rejects; knotter and second screen rejects of raw groundwood; *semi-chemical chips of all kinds;* spent chips after extraction process; bagasse, straw, and similar grasses; breaking down lumps in reclaimed waste paper stock; reduction and refining of rag and other half stocks, etc., etc.



125

Sprout Waldron
Manufacturing Engineers
SINCE 1866
MUNCY • PENNSYLVANIA

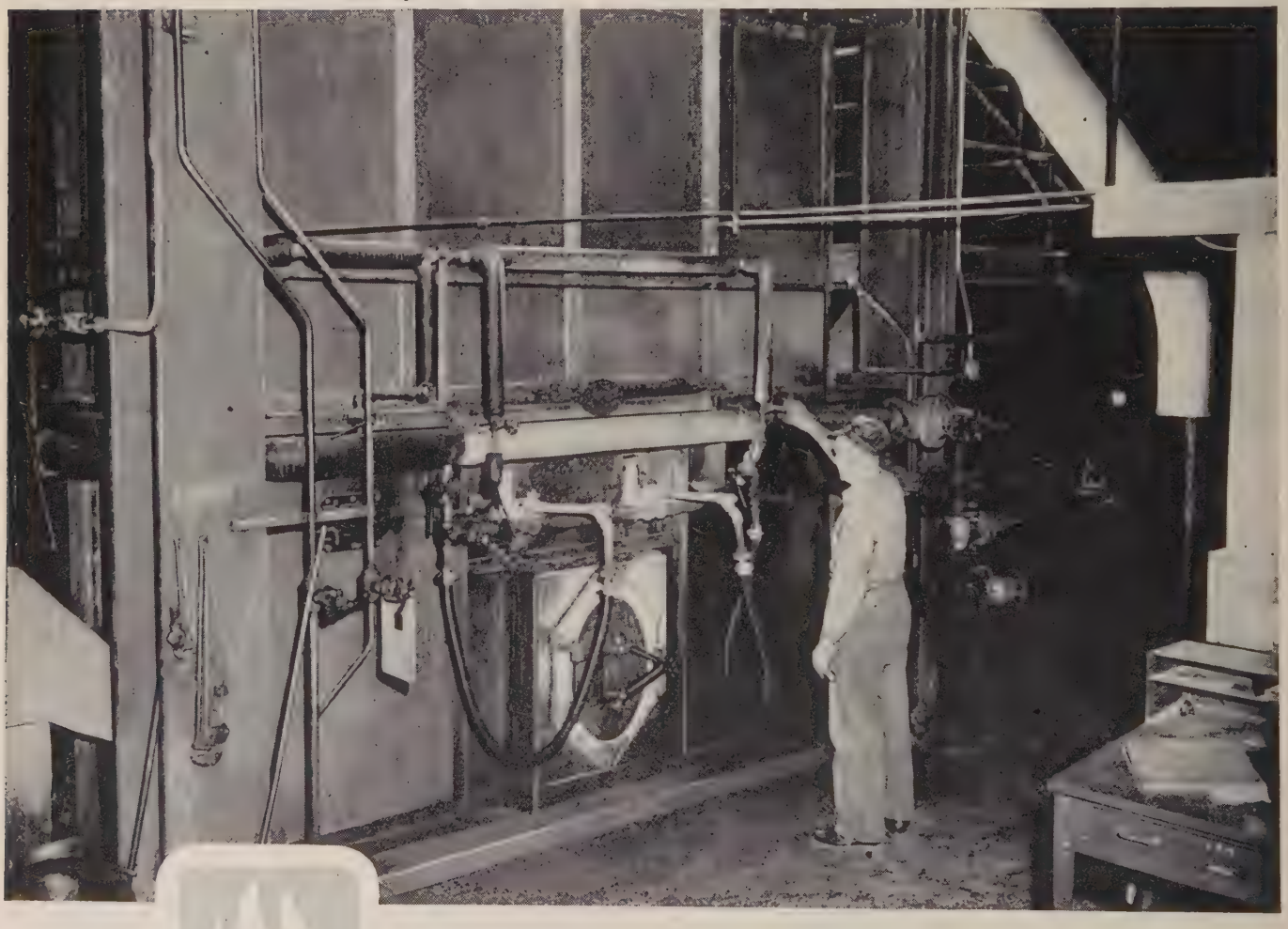
Longview Fibre Company Modernizes with C-E Recovery Unit

A new C-E Recovery Unit – replacing three over-age units – recently began operation at the modernized steam and electric plant of the Longview Fibre Company, Longview, Washington. The new unit is located in the space formerly occupied by two of the older recovery units. This arrangement afforded substantial savings in material and construction costs, while requiring only moderate alteration of the original building.

The C-E Recovery Unit is a specially designed 3-drum vertical pass arrangement with a 2-drum integral economizer section in the last pass. The superheater is located in the first pass of the boiler, directly above the water-cooled furnace. The Unit is designed to burn 600,000 pounds of black liquor solids per 24 hours and will produce steam at 825 psi and 750F.

The reliability, economy and operating efficiency of the C-E Recovery Unit are well known. And, as you would expect, more and more mills have selected C-E for both new installations and expansion of existing ones. B-375

Firing level showing black liquor spray burners.



C-E

COMBUSTION ENGINEERING—SUPERHEATER, INC.

200 Madison Avenue • New York 16, N. Y.

PRODUCTS FOR THE PAPER INDUSTRY INCLUDE RECOVERY UNITS, STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; ALSO PRESSURE VESSELS

CHEMIPULPER

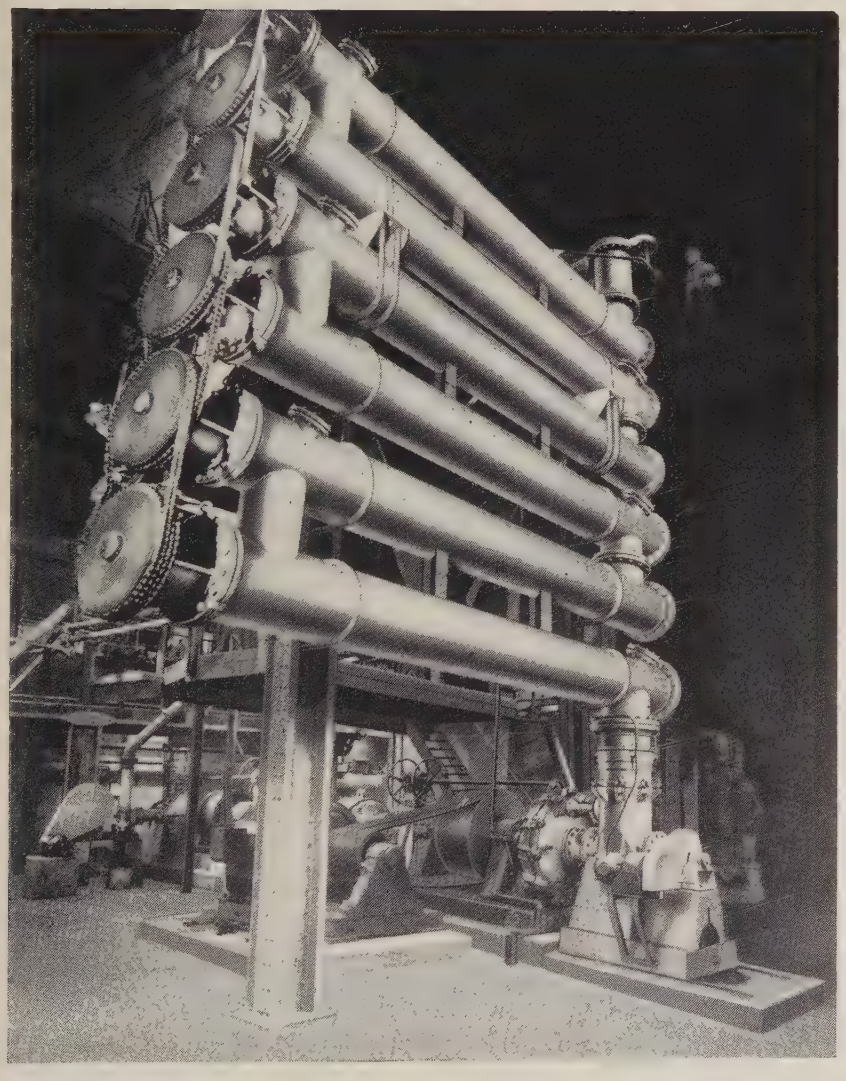
(Patented and Patents Pending)

50 OPERATING INSTALLATIONS IN THE PULP AND PAPER INDUSTRIES

The Chemipulpers in these mills are making uniform pulp, at low cost, for insulating board; flooring, roofing and automotive felts, and corrugating board. Other grades of pulp are made from either hard or soft woods, or mixtures of such woods.

The Chemipulper operates as a continuous digester for cooking and pulping of chemical and semi-chemical pulps . . . in 150 to 175 p. s. i. steam pressure range. Uses either neutral sulphite or alkaline cooking liquors.

Cooking factors of time, temperature and chemicals adjustable to conform to variables in raw materials and to accurately meet predetermined requirements.



The Reaction Chamber is made in units and the number of these can be varied according to the degree of treatment required.

Illustration shows combination of Asplund Defibrator with multiple-unit REACTION CHAMBER

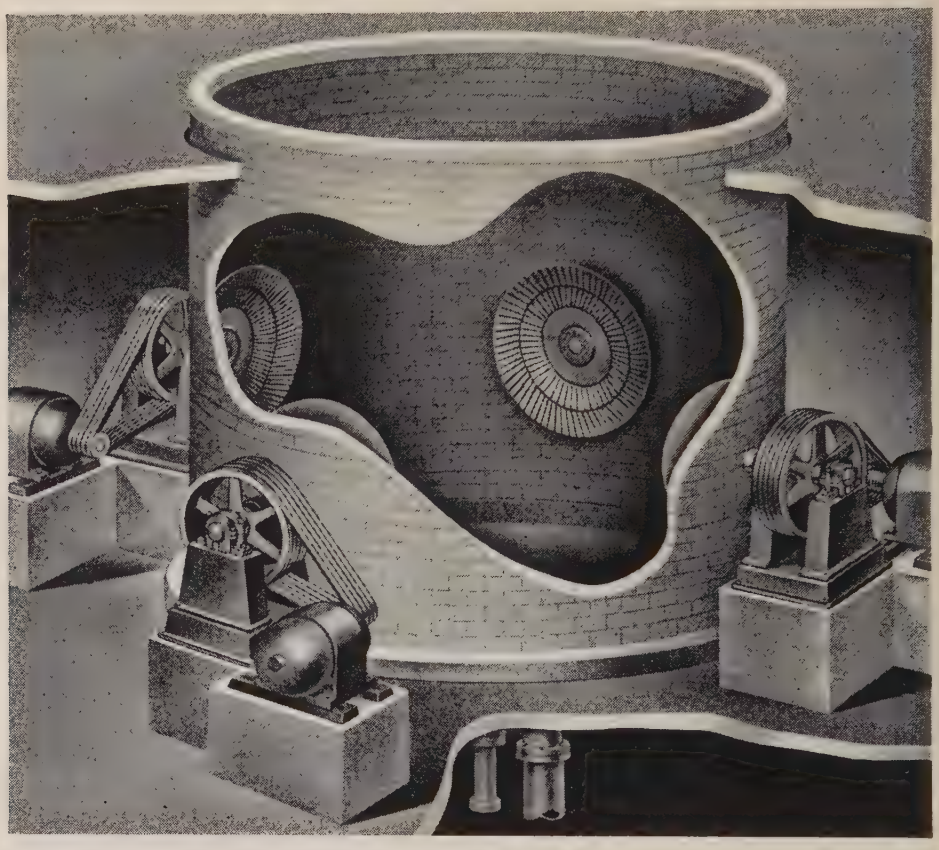
Catalog upon request

PAPER and INDUSTRIAL APPLIANCES, INC.
122 EAST 42nd STREET NEW YORK, N. Y.

Here's the New Rice Barton

QuatroPulper

. . . a high production machine . . . ideal for disintegrating pulp, broke or waste paper



THE stock is charged all at one time into the top of the vat. Four DynoPellers (described below) subject it to the vigorous dynomizing action that completely separates each fibre from its neighbor, maintaining its original length. The simple operating principle and design of the QuatroPulper eliminates the "wracking" and grief of other types of pulpers. Because there are few moving parts there is no loss of production time due to repair or adjustment. The QuatroPulper defibers the stock at low cost and produces a high quality slurry quickly and effectively.

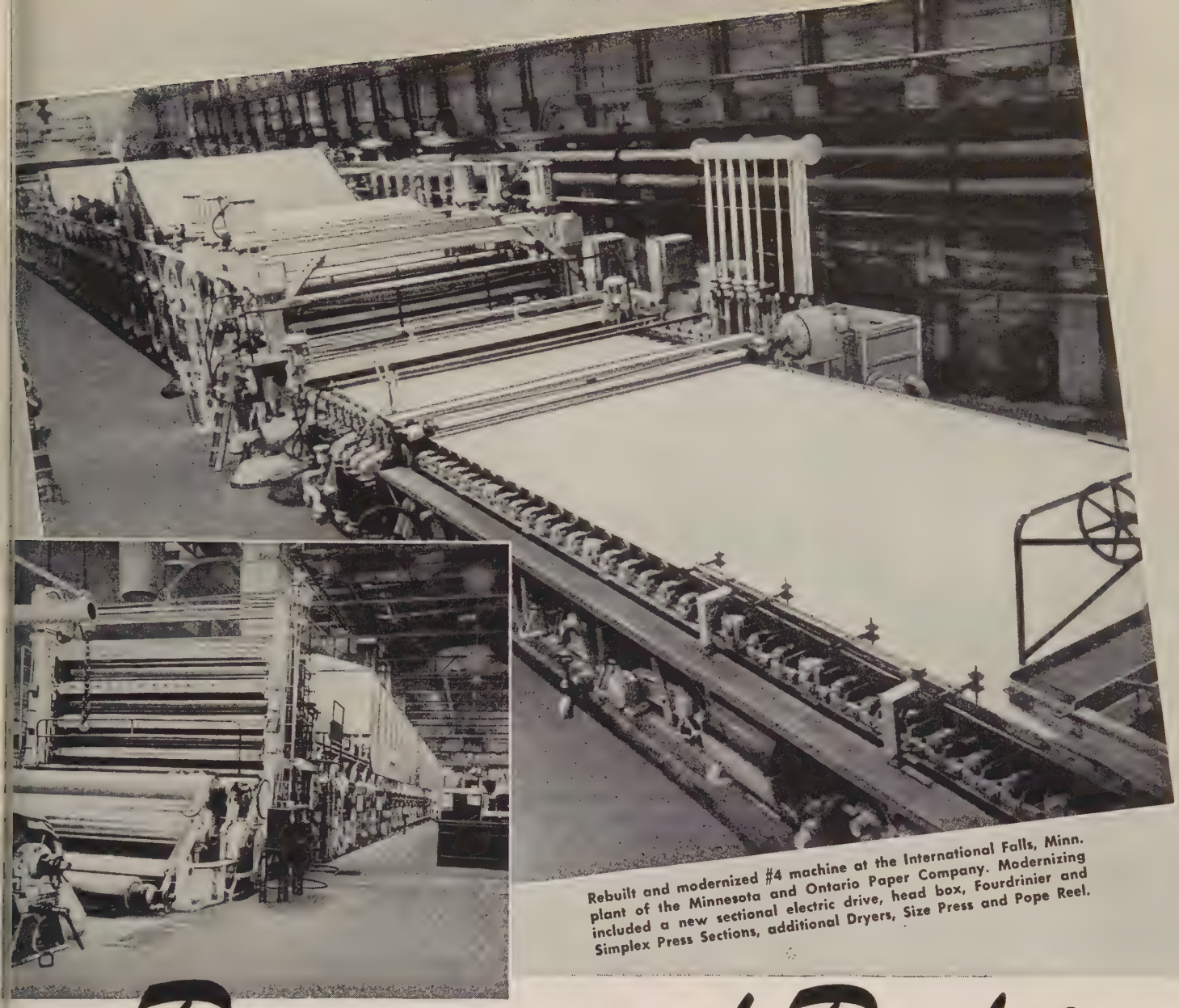
Let us tell you how the QuatroPulper can save YOU *money in processing* YOUR *particular stock. Write today.*

The DynoPeller · · · · · ·▸ is the heart of all DynoMachines. Its concave face is lined with rough, hard carbide particles. As the DynoPeller rotates it causes a suction at its center that pulls the stock towards it. Centrifugal force then causes the stock to flow rapidly over the rough carbide particles. This effective dynomizing action completely disintegrates the stock . . . separating each fibre from its neighbor while maintaining its original length.

RBR8

RICE BARTON Research Corporation

WORCESTER 1, MASS.



Rebuilt and modernized #4 machine at the International Falls, Minn. plant of the Minnesota and Ontario Paper Company. Modernizing included a new sectional electric drive, head box, Fourdrinier and Simplex Press Sections, additional Dryers, Size Press and Pope Reel.

Progress and Profits
are Built on Modernization

Puseyjones engineers have assisted in the rebuilding and renovation of paper making machines in many leading mills across the country—stepping up speeds, improving qualities, increasing profits. An outstanding job of modernization carried out by Puseyjones is the rebuilt and modernized machine of the Minnesota and Ontario Paper Company shown above. This 184 inch machine was originally installed in 1910.

A machine modernization program may call for the addition of a new appliance, the replacement of an obsolete drive, or may involve the complete rebuilding of the machine itself.

When maintenance costs become excessive or when a greater range of higher grade paper products is required, get the benefits of Puseyjones experience. Talk over your machine rebuilding problems with Puseyjones engineers. Write us today.

THE PUSEY AND JONES CORPORATION

Established 1848. Builders of Paper-Making Machinery

Wilmington 99, Delaware, U.S.A.

THE SIGN OF TRADE MARK

In white water treatment...

THE DORRCO CLARIFLOCCULATOR

RECOVERS FIBER

RECOVERS FILLER AND COATING CHEMICALS

PREVENTS STREAM POLLUTION

in one operation...

The Dorrco Clariflocculator is a two-in-one unit providing mechanical flocculation coupled with continuous sedimentation and clarification . . . all in a single compact structure. In operation, solids are continuously withdrawn from a central sludge cone and a clear effluent is overflowed peripherally across a weir extending completely around the tank.

The case history at the right is based on Dorrco Clariflocculator operation at a large Wisconsin Paper Mill. At this mill, alum is added in the paper-making step to hold pH at 4.2 for best paper machine operation. Similarly, activated silica is used in a sufficient amount for best fiber retention on the wire. Consequently, no additional flocculating reagents are necessary, although in other cases they may be required for optimum results.

Regardless of the exact nature of your white water problem, there's a good chance that the ability of the Dorrco Clariflocculator to recover flotable and non-flotable material . . . *simultaneously* . . . may mean money in your pocket. Why not check with a Dorr engineer?

Name:_____ *

Equipment: One 30' dia. Dorrco Clariflocculator.
Flow: 300 gpm.
Feed: White water from paper mill. Solids contain 17–74% clay, starch, titania and other coating materials.
Chemicals Used: Paper Makers' Alum and activated silica.

Test No.	Solids—lbs./1,000 gal. Feed	Effl.	Sludge	% Recovery	Sludge % Solids
1	8.38	0.16	35.69	98.5	0.43
2	6.57	0.16	43.82	97.8	0.53
3	3.90	0.16	28.39	96.3	0.34
4	5.40	0.16	25.98	97.6	0.31

Comments: Pulp is sulphite and groundwood. Feed contains dissolved air tending to form scum but the flocculation effectively eliminates this problem and produces an excellent effluent.

* *Name on request.*

DORRCO

THE DORR COMPANY, ENGINEERS
BARRY PLACE, STAMFORD, CONN.

NEW YORK • ATLANTA • TORONTO
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SUGAR PROCESSING
PETREE & DORR DIVISION, STAMFORD, CONN

ASSOCIATES AND REPRESENTATIVES
Dorr Technical Services and Equipment Are Also Available Through Associated Companies and Representatives in the Principal Cities of the World
Names and Addresses on Request.

DORR

RESEARCH ENGINEERING EQUIPMENT

National Aniline Dyes

are

Outstanding Colors

NATIONAL ANILINE DIVISION

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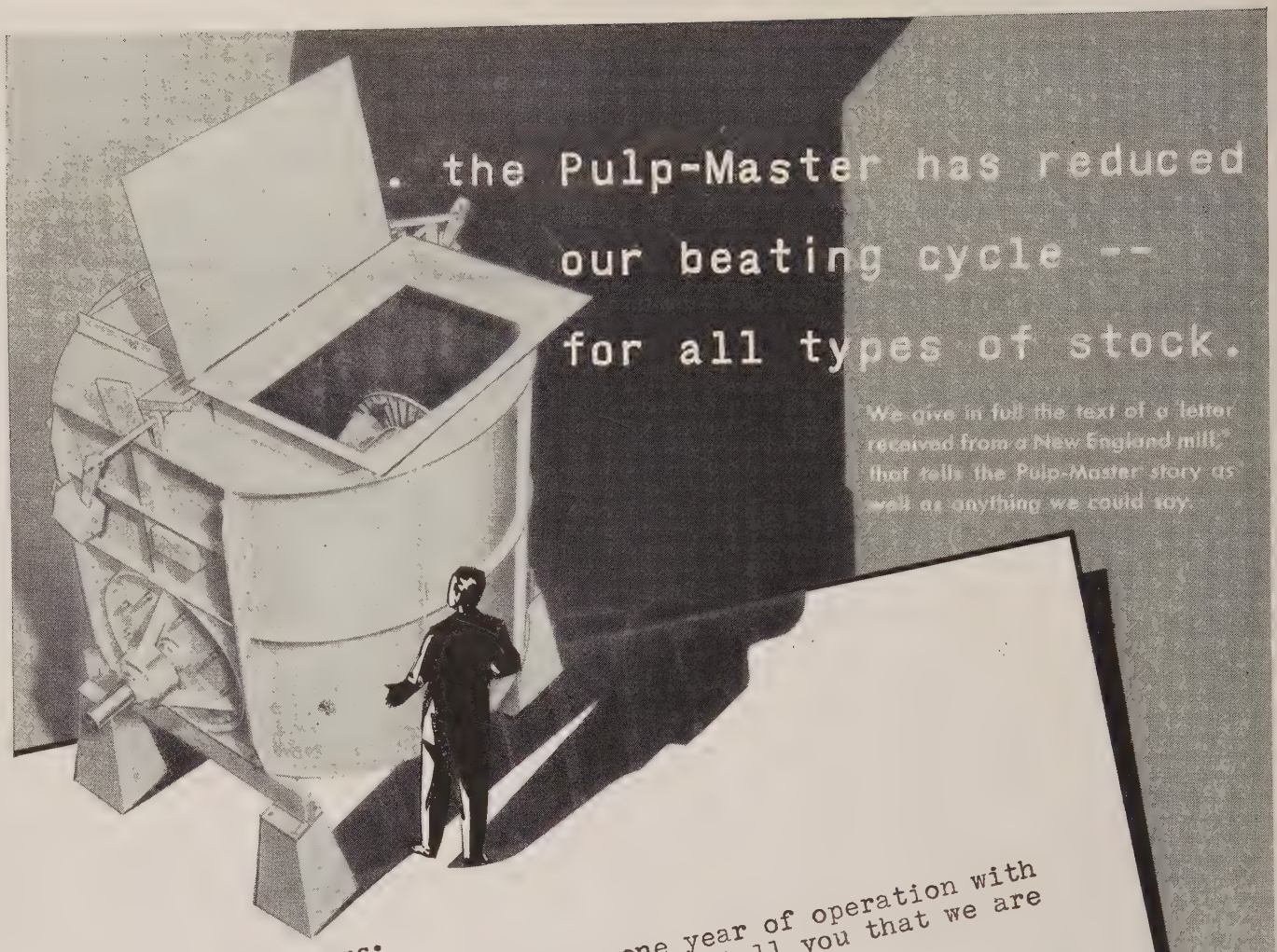
Boston Providence Philadelphia Chicago
San Francisco Portland, Ore. Greensboro Charlotte
Atlanta New Orleans Chattanooga Toronto



. . the Pulp-Master has reduced our beating cycle -- for all types of stock.

We give in full the text of a letter received from a New England mill,* that tells the Pulp-Master story as well as anything we could say.

Dear Mr. Williams:

We have completed approximately one year of operation with our Jones Pulpmaster and are happy to tell you that we are entirely satisfied with this equipment.

While our Pulpmaster is used primarily as a stock breaker we have found that it is quite capable of rendering sufficient hydration and defibering action so that with over 50% of our stock only additional treatment in one Jordan is necessary before it is ready for the paper machine. The balance of our stock consisting almost entirely of foreign unbleached sulphite and kraft is treated in one to three Jones #1 Refiners before going onto the paper machine. In all cases we operate our Pulpmaster with stock of high consistency - 5½% to 7%.

We have found that use of the Pulpmaster has reduced our beating cycle from six or seven hours to one hour or less for all types of stock used, with a subsequent reduction in the labor required in our beater room.

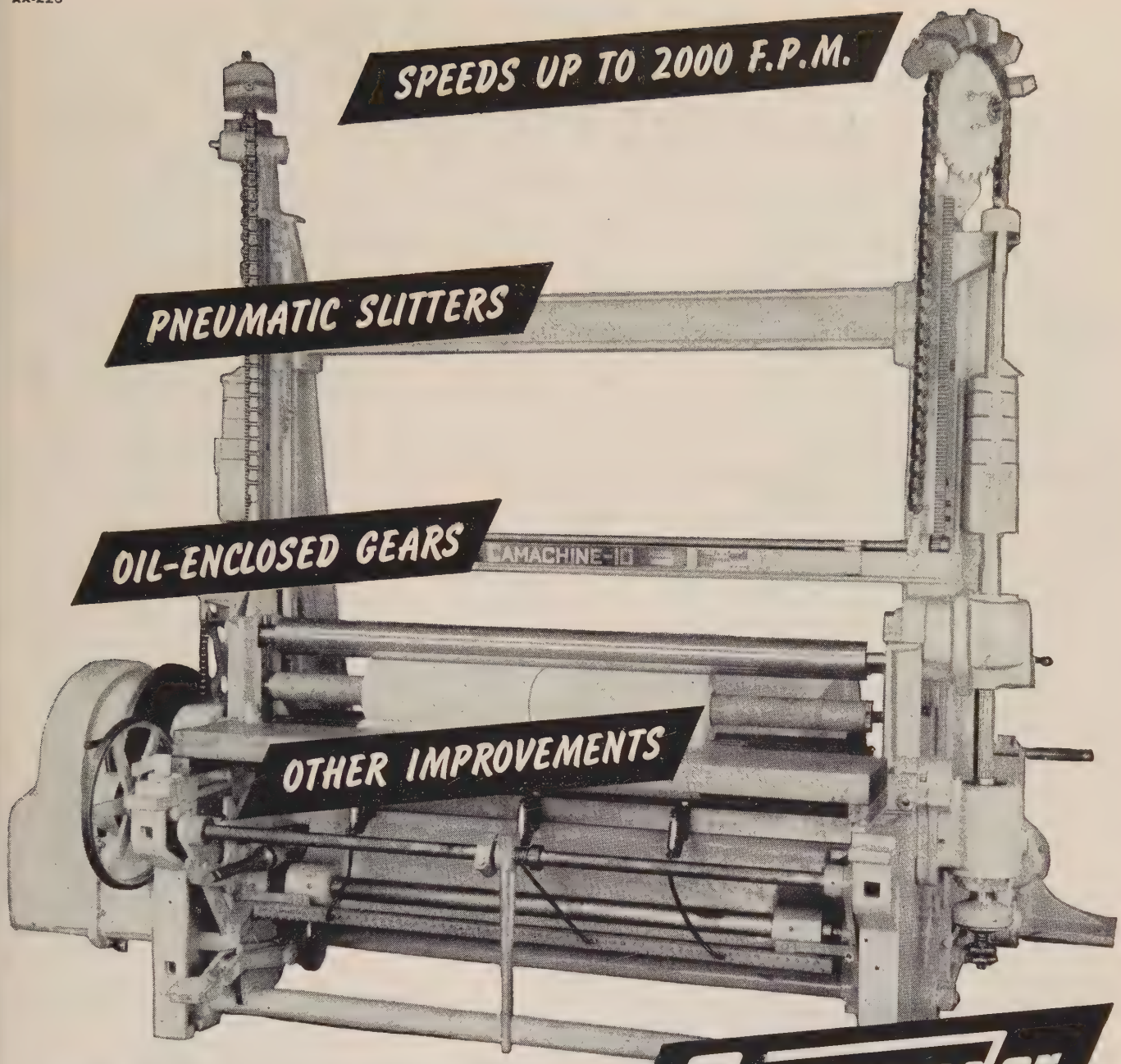
*We'll be glad to send a facsimile copy of the letter and descriptive bulletin No. EDJ-1019A if you'll write us.

E.D. Jones

E. D. Jones & Sons Company, Pittsfield, Mass.

BUILDERS OF QUALITY STOCK PREPARATION MACHINERY

AA-220



with the new Camachine Commander

A VERSATILE, NEW HIGH-SPEED SLITTER-REWINDER
FOR MILLS, MANUFACTURERS AND CONVERTING PLANTS

THE NEW COMMANDER truly represents one of the greatest advances in Cameron's half century of specialization in slitter-rewinder engineering. Cameron experience and imagineering have blended in the *Commander* to provide new high speeds, new trouble-free dependability, and new features for top quality roll production at new low costs.

Makers and users of plain, waxed, gummed and coated papers or paper board will find the *Commander* a highly profitable addition to plant production facilities.

Among the outstanding features of the new *Commander* are the following:

The *Camachine Pneucut* pneumatic slitters allow pressure on the entire line of cutters to be controlled from a single point. Pneumatically controlled pressure assures cleaner cutting through longer runs, with no time lost for separate cutter adjustments. Shear cut units may be specified.

The main drive unit is now completely enclosed for safety, while the main drive shaft outboard bearing support has been made an integral unit of the main frame, assuring exact alignment.

All gearing is now completely enclosed and running in a bath of oil, for longer life and added safety.

You'll like the new style of the *Commander* too. It's a good-looking machine to have on the floor, and it pays off day after day in fast, high quality, trouble-free production. You are invited to send for complete information.

Camachines *FOR FAST, TOP QUALITY ROLL PRODUCTION*

CAMERON MACHINE COMPANY • 61 POPLAR STREET • BROOKLYN 2, N. Y.

. . . the world over

WOOD PULP, PAPER, AND BOARD PRODUCTION IN THE UNITED STATES, 1949*

Preliminary

Wood pulp production amounted to 12,137 thousand tons, and paper and board output totaled 20,304 thousand tons in 1949, according to a preliminary report issued recently by the Bureau of the Census, Department of Commerce. These figures represent declines from 1948 of 6% in wood pulp and 7% in paper and board production.

Production of all grades of wood pulp declined in 1949 except bleached and semibleached sulphate, which showed increases of 8 and 16%, respectively. The grades of wood pulp that declined in production and their per cent decreases

* Prepared by Bureau of the Census, Industry Division, Wood Products Section.

Table I. United States Production of Wood Pulp and Consumption of Wood Pulp, Pulpwood and Other Fibrous Materials in the Manufacture of Paper and Board, by Kinds, 1949 and 1948

(Tons of 2000 Pounds)

Type of material	*Production*		*Consumption*	
	1949[a] Preliminary	*1948*	*1949[a] Preliminary*	*1948*
ALL FIBROUS MATERIALS (EXCLUDING PULPWOOD)	12,137,188	12,872,292	21,371,366	23,496,177
WOOD PULP, TOTAL	12,137,188	12,872,292	13,608,096	14,346,847
Sulphite, total	2,537,084	2,811,216	3,017,304	3,334,121
Bleached	1,826,598	1,909,402	1,847,685	1,856,321
Unbleached	710,486	901,814	1,169,619	1,477,800
Sulphate, total	5,968,557	6,013,696	6,676,080	6,663,514
Bleached	1,122,226	1,040,055	1,492,793	1,305,373
Semibleached	261,347	224,751	273,114	251,465
Unbleached	4,584,984	4,748,890	4,910,173	5,106,676
Soda	491,822	509,864	525,452	521,370
Groundwood	1,962,141	2,175,107	2,206,961	2,447,930
All other	1,177,584	1,362,409	1,182,299	1,379,912
FIBROUS MATERIALS OTHER THAN WOOD PULP, TOTAL	...	...	7,763,270	9,149,330
Waste paper	...	...	6,552,832	7,648,510
Straw	...	...	382,743	523,611
Rags	...	...	384,034	425,468
Flax	...	...	54,303	60,969
Miscellaneous fiber	...	...	389,358	490,772
PULPWOOD, TOTAL	...	...	19,880,794	21,189,458
Softwood	...	...	17,274,197	18,490,916
Hardwood	...	...	2,606,597	2,698,542

[a] These data are estimated to give 100% coverage of the industry. The over-all percentage of estimates are: wood pulp production, 2.6%; wood pulp consumption, 2.8%; consumption of all other fibrous materials, 1.4%; and consumption of pulpwood 2.5%. In no case does the proportion of estimate for the several grades of wood pulp, other fibrous materials, and pulpwood exceed 5%.

Source: Data represent a summation of the monthly "Facts for Industry" Reports (Series M14A) for the industry, revised to include late and corrected reports received subsequent to the publication of the monthly release.

Table II. Paper and Board Production in the United States: 1947, 1948, and 1949

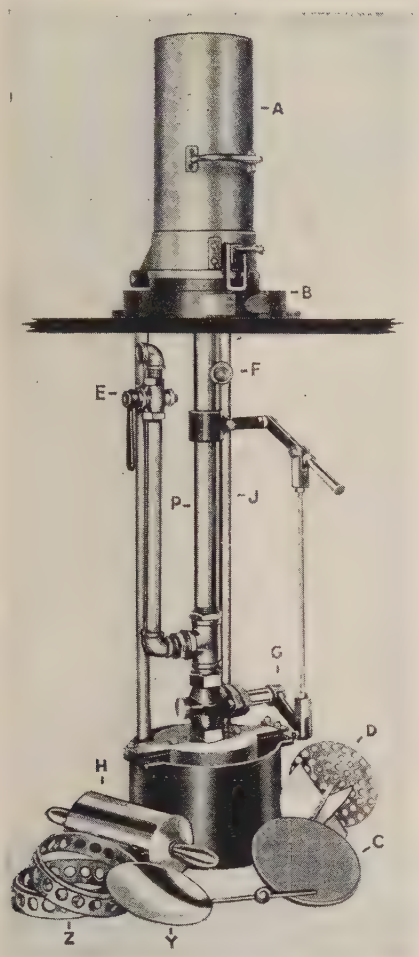
(Tons of 2000 Pounds)

Type of product	*1949[a] Preliminary*	*1948*	*1947*	*Type of product*	*1949[a] Preliminary*	*1948*	*1947*
ALL TYPES, TOTAL	20,304,243	21,921,757	21,114,000				
PAPER, TOTAL	9,232,426	9,800,029	9,415,909	PAPERBOARD (*Continued*)			
Newsprint	916,042	875,760	833,038	Corrugating material	1,342,178	1,372,691	1,370,492
Groundwood paper	804,810[b]	808,110	821,318	Container chip and filler board	267,448	269,933	279,968
Book paper	2,151,759	2,338,671[c]	2,207,923[c]	Folding boxboard	2,055,471	2,182,354	2,256,691
Fine paper	1,027,309	1,141,702	1,171,539	Set-up boxboard	600,730	595,927	594,755
Coarse paper (including shipping sack)	2,827,330	3,024,846	2,903,450	Cardboard	71,625	86,790	91,858
Special industrial paper	270,264	315,900	289,499	All other paperboard	1,618,025	1,424,774	1,299,812
Sanitary paper	956,265	982,644	894,032	Wet machine board	120,684	134,285	149,800
Tissue paper	199,189	205,095	194,624	Building material made of pulp	1,995,083	2,618,669	2,361,481
Absorbent paper	79,458	107,301	100,486	Building paper and insulation	1,112,688	1,348,321	1,289,109
PAPERBOARD, TOTAL	8,956,050	9,368,774	9,186,810	Building board	882,395	1,270,348	1,072,372
Liners	3,000,573	3,436,305	3,293,234				

[a] Data for 1949 are estimated to give 100% coverage of the industry. The over-all percentage of estimate for all types of paper and paperboard is 1.8% In no case does the proportion of estimate for any of the several grades of paper and board exceed 4%.
[b] Includes some paper-machine coated paper having a groundwood content of over 25%.
[c] Includes paper-machine coated paper, all grades.
Source: Data for 1949 compiled from monthly reports on Form M14A, "Domestic Pulp and Paper Monthly Report." Data for 1948 are from "Facts for Industry," Series M14D "Wood Pulp, Paper and Board—1948," and data for 1947 are from the 1947 Census of Manufactures.

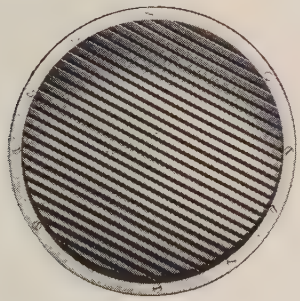
*TAPPI STANDARD

PULP TESTING—SHEET MAKING APPARATUS



*SHEET MACHINE—DRYER RINGS—DISCS

*DISINTEGRATOR



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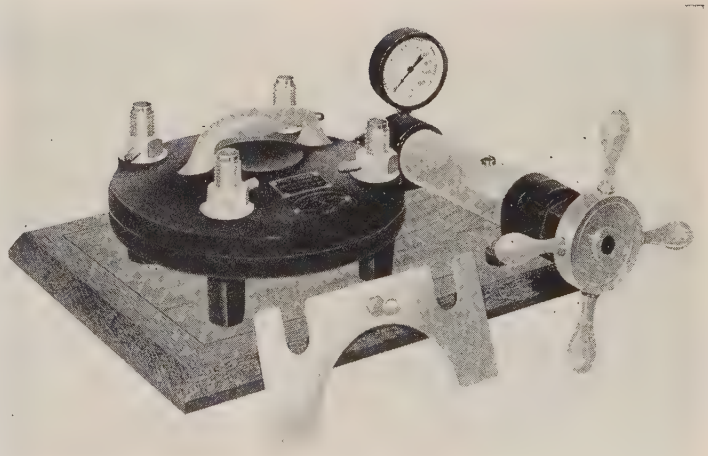

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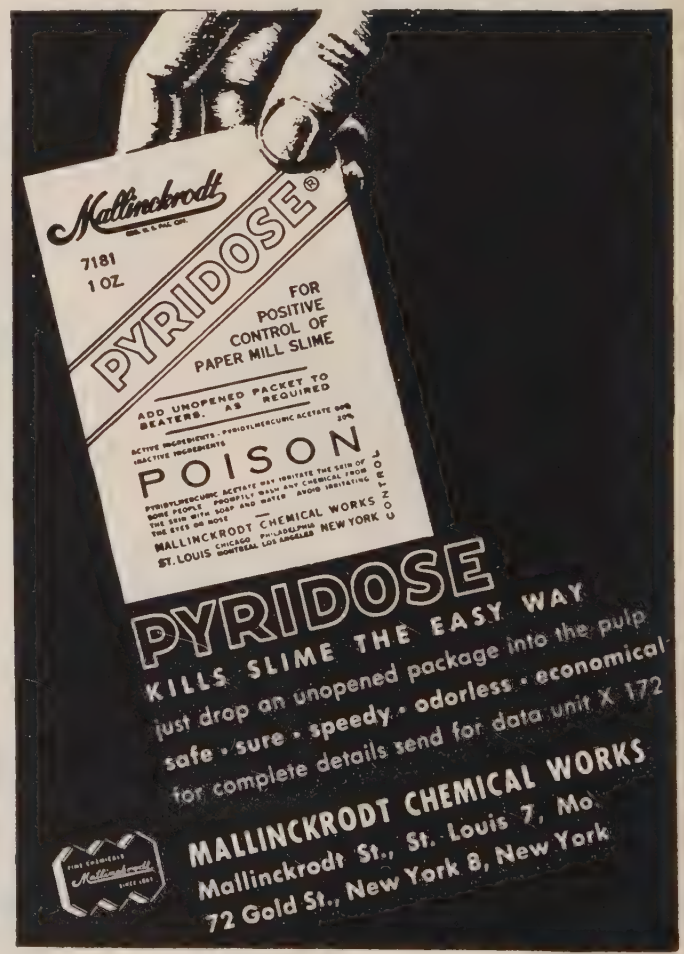
are: unbleached sulphite, 21%; groundwood, 10%; bleached sulphite, 4%; soda, 4%; unbleached sulphate, 3%; and all other (semichemical, chemfiber, defibrated, exploded, screenings, off-quality pulp, etc.), 14%.

The consumption of wood pulp in the manufacture of paper and board, at 13,608 thousand tons, reflects a decrease of 5% from the record consumption in 1948. Pulpwood consumption amounted to 19,881 thousand cords, measured on a roughwood basis, as compared with 21,189 thousand cords in 1948. Consumption of fibrous materials other than wood pulp during 1949, at 7763 thousand tons, was 1386 thousand tons below the comparable figure for 1948. Approximately 1100 thousand tons of the decrease represent the decline in the consumption of waste paper.

Paper production, exclusive of building grades, totaled 9332 thousand tons, almost 600 thousand tons less than the 1948 figure. Production of all major paper grades, except newsprint, declined in 1949. The output of newsprint reflected an increase of over 4%.

Paperboard output in 1949 amounted to 8956 thousand tons, a decrease of more than 4% from that reported in 1948. Building materials made of pulp amounted to 1995 thousand tons, 24% less than in 1948. Production of building paper and insulation declined approximately 17%, and the output of building board decreased 30%.

The preliminary 1949 data are the result of a summation of the monthly reports on Form M14A, "Domestic Pulp and Paper Monthly Report." The statistics represent a complete coverage of the operations of all known wood pulp, paper, paperboard, and building board mills. Final and more detailed data will be published in a summary report at a later date.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Kamyr attacked the problem of pulp bleaching at a time when direct chlorination first made its appearance on an industrial scale. Until then progress had been by steady but slow evolution, but this process started a period of revolutionary development. Kamyr made its start by introducing specially designed circulation pumps. Special Kamyr items already in use throughout the pulp industry were ultimately to form part of the KAMYR BLEACHING SYSTEM.

The soundness of Kamyr's theories developed and applied during these pioneering days has been proven by their adoption throughout the trade. Kamyr's emphasis on separate washing after each treatment, though long scorned, came to be accepted as standard procedure in *all* modern bleaching. The Kamyr vacuum washer meets any demand as to capacity, efficiency and resistance to chemicals.

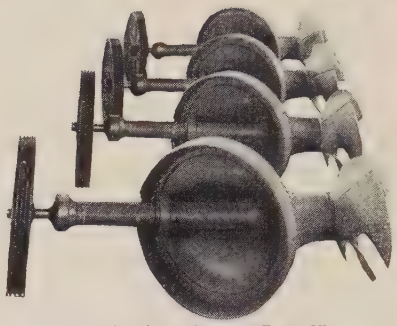
Kamyr's solution for the efficient mixing and absorption of chlorine offers one of its strongest claims of superiority. Installation of a circulation pump at the base of the chlorination tower converts the bottom into a mixing chamber. The inlet and outlet of the pumps are connected tangentially to produce a strong horizontal circulation. The chlorine and pulp are thoroughly mixed. The pulp rises to the top of the tower and flows to the following washer.

Pre-Impregnation Process

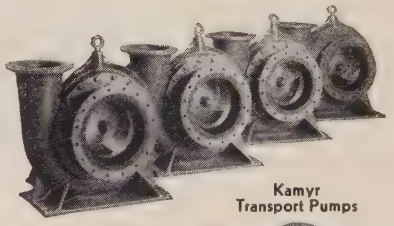
The Kamyr patented process for pre-impregnation at low density for high density pulp assures excellent impregnation thus producing a more uniform pulp, a higher alpha content and an increased yield.

Sandy Hill's staff includes an engineer with more than 20 years world-wide experience in the Kamyr organization available for consulting services.

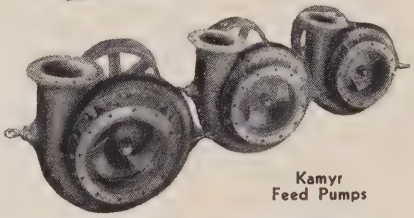
A brochure on the Sandy Hill-KAMYR bleaching process, just off the press, will be sent upon request.



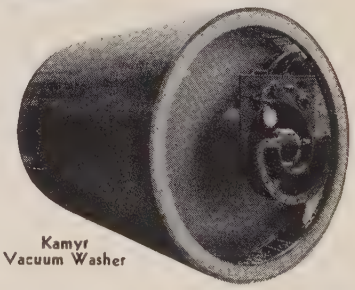
Kamyr Circulation Pumps—Type CT



Kamyr Transport Pumps



Kamyr Feed Pumps



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Processes Being Used in Europe for Manufacture of Straw Pulp

JOSEPH E. ATCHISON

THE information which is discussed in this paper was obtained as the result of a five-month survey of the pulp and paper industry of seven of the Western European countries during the summer of 1949. The purpose of the survey was to investigate the present and potential utilization of hardwoods, straw, and other agricultural residues in the Marshall Plan countries. This paper will be limited to a discussion of the processes being used for manufacture of straw pulp and paper. However, a rather good cross-sectional view of the pulp and paper industry, in general, in each country was obtained, and some of the information has been or will be published in other papers.

The survey included Italy, France, Western Germany, Austria, Belgium, Holland, and the United Kingdom. In view of the very limited quantities of pulpwood available in most of these countries, extensive use of straw and other agricultural residues as a source of fibrous raw material is of far greater importance than their use in countries with adequate pulpwood supplies. Their use becomes a necessity if the present low rates of paper consumption in Europe are to be increased to any appreciable extent. We in ECA feel that extensive development of the use of straw can become of great importance to the pulp and paper industries in many of the Marshall Plan countries, and such development is being encouraged in every way possible.

STRAW PREPARATION AND CLEANING EQUIPMENT

One of the most noticeable differences between methods used in the United States and Europe in pulping straw involves the preparation and cleaning equipment used before the straw enters the digesters. Almost all of the straw pulp mills in Europe use an elaborate straw preparation and cleaning system. This system was originally designed and manufactured before the war by the Max Grumbach Mechanical Factories in Freiberg, Germany and the author saw Max Grumbach equipment throughout Europe's straw pulp mills. However, Freiberg is now in the Russian occupied zone of Germany and it is rather difficult to determine what the extent of their present activities might be.

Since the war, The Cellulose Development Corp., 9, Anselyn Road, Middlesex, England, has taken over the Max Grumbach patents and designs, and this company has been manufacturing the complete line of straw preparation equipment for use in mills all over the world. They have made improvements in design and operation of the equipment so that former operational difficulties have been eliminated.

JOSEPH E. ATCHISON, Chief, Pulp and Paper Section, Forest Products Branch, Economic Cooperation Administration, Washington, D. C.

Since some of this equipment might be of interest to the strawboard companies represented here from the standpoint of possible use in their operation, the author will attempt to describe it in some detail.

The first item of equipment in the system is a straw cutter to which the bales of straw are fed continuously. Each cutter is capable of handling about 80 tons of straw per day or enough to produce 30 tons of finished bleached pulp. All straw mills in Europe use cutters similar to this whether they produce strawboard, bleached straw pulp, or wallboard. After passing through the cutter, the straw and fines usually are dropped into a hopper below the cutter from which they are sucked through large pipes into the side of a cyclone separator located at the top of the building. The loose fines and dust are sucked through a screen at the top of the cyclone and are drawn out through a water spray chamber and discharged as waste. The screen at the top of the separator is kept clean by means of a mechanical brush. The accepted straw from this operation drops to the bottom of the separator and passes out through a rotating seal so that the suction is not lost.

Many of the mills send the straw directly to the digestion equipment from this point. However, some of the mills in which bleached pulp is produced carry the cleaning process, before digestion, much further. In these mills the straw from the cyclone drops into a rotating thresher or beater which further loosens additional dirt and fines. From this it passes into the large end of a rotating, conical shaped screen containing round holes of about 1.5 mm. in diameter. The fines and heavy dirt of small particle size pass through the screen and are discarded. Accepted stock is then passed over a horizontal shaker screen on which a large portion of the nodes and grain are removed. The screen has holes of about 4 to 5 mm. in diameter and the nodes and grain, which are heavier than the straw fiber, go through the screen. These are then passed through a grain separating device in which the grain is separated from the nodes. The clean accepted straw from the screen is then conveyed to storage bins or directly to the digesters.

Some of the mills which are producing bleached pulp have found that it isn't necessary to use such an elaborate dry-cleaning process. These mills merely use the cutter and cyclone separator and remove nodes, grain, and remaining dirt after the straw is cooked. This is done by means of screens, rifflers, vortraps, etc. By using the latter method it is possible to obtain higher

(*continued on page 44 A*)

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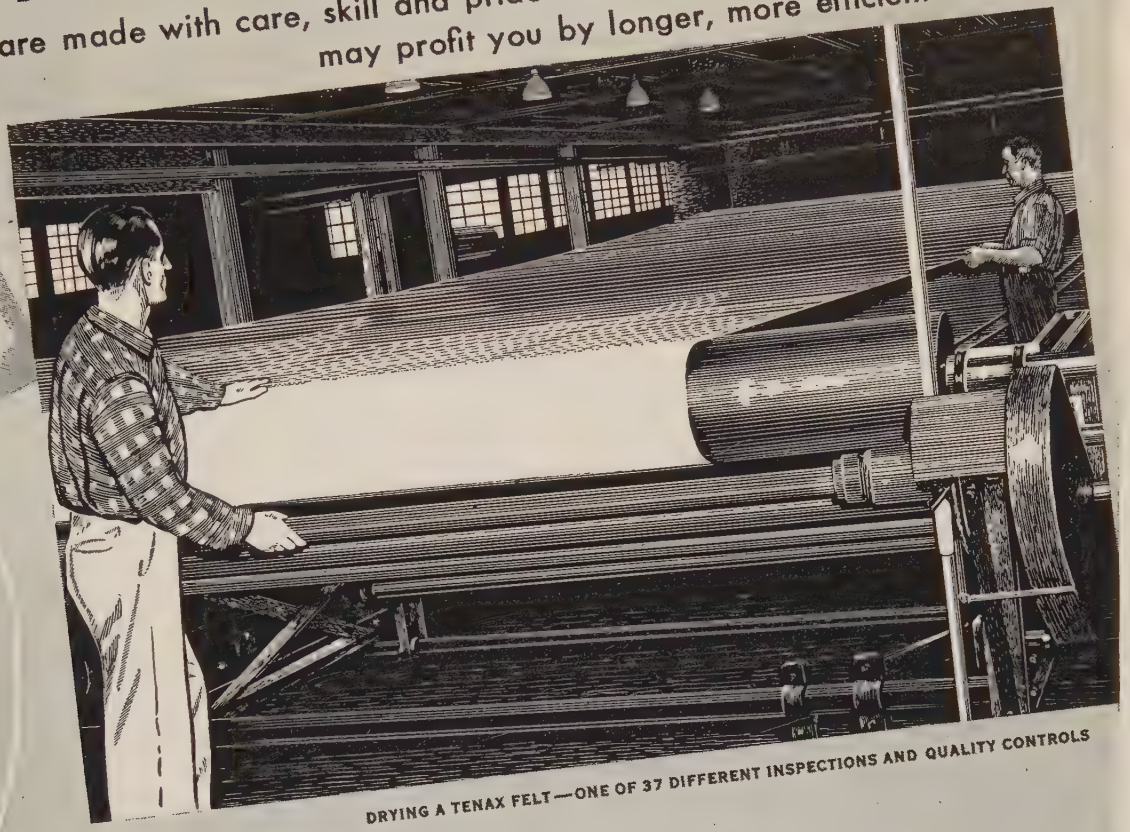

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(*continued from page 42 A*)

over-all yields of pulp based on the dry weight of the straw as received.

STRAW PULPING PROCESSES

There are a great number of pulping processes in use in Europe for the production of pulp and paper from straw. No attempt will be made to describe all of the modifications of the various processes in use, and the author will concentrate on those actually seen in operation. There is no intention to favor any one process over the others although some of the less conventional processes may be stressed because less development work has been done on them in the United States and therefore they may be of more interest.

The Lime Process

Just as in the United States, the traditional lime process with rotary globe digesters is used more widely in Europe than any other process for utilization of straw. Large quantities of strawboard and low quality straw wrapping paper are produced by this process. In France and Italy it is used by a great number of small, family operated mills each of which produce small quantities of from a few hundred pounds to 2 or 3 tons per day. On the other hand in Holland, Germany, and Belgium the mills are fewer in number but are larger in size. Several mills in Holland produce as much as 1000 tons of strawboard per day of all weights and for all purposes from corrugating paper to the heaviest boxboard.

Most of the mills which use the lime process do not wash the pulp after cooking, thus it goes to the paper machine with all fines and residual chemical present. This practice results in very high yields of about 85%, but the quality of the product is very poor and as a result many of the mills are rapidly losing markets in competition with higher quality board produced by other processes.

The Caustic Soda and Sulphate Process

The conventional soda process is coming more and more into use, especially in Holland, for production of a higher quality board than can be produced by the lime process. However, at the time of the visit in Holland, the mills using this process did not wash the pulp before running it to the board machine, so many of the advantages of the process were lost. Steps are being taken by some of the mills to install washing equipment in the future.

The soda process is in use in Western Germany for production of bleached straw pulp on a small scale. They cook the straw in rotary globe digesters with caustic soda alone using about 12% caustic soda on the basis of the dry weight of the straw, and cooking for 5 hours at 160°C. The yield of bleached straw pulp obtained by this process is about 40% based on the moisture-free weight of the straw. The pulp is bleached in a one-stage bleaching process using hypochlorite alone and is used in various grades of fine papers in Germany.

The only bleached straw pulp mill in Holland is now using the sulphate process for production of a rather good quality bleached straw pulp.

During the war, when supplies of esparto grass were cut off from North Africa, the esparto mills in the United Kingdom turned to straw as a source of fibrous raw material. As much as 120,000 tons of bleached straw pulp per year were produced by the soda process in these mills. Because of the great differences between esparto and straw, the esparto mills experienced many difficulties in converting to straw. All of these mills had soda pulping equipment with stationary vertical digesters specifically designed for esparto, and this equipment was not entirely suitable for economic production of straw pulp. At first they attempted to use the same process with the same concentration of cooking chemicals and the same cooking time as had been used with esparto, and as a result, a very poor quality pulp was produced. By gradually modifying this process somewhat, they were eventually able to produce a suitable pulp. However, the operation was never as successful as it could have been if the straw had been pulped in equipment and by a process specifically designed for straw.

Because of the difficulties involved and their traditional use of esparto, the use of straw for bleached pulp was considered a temporary expedient. Thus, when esparto became available again after the war, almost all of the mills reverted to the use of this raw material with which they were completely familiar and for which their old equipment had been designed. The production of bleached straw pulp by the conventional soda process decreased rapidly and there is very little bleached straw pulp being produced by this process in the United Kingdom at the present time. However, other processes specifically designed for straw pulping are coming into greater use in the United Kingdom.

The Monosulphite Process

The monosulphite process for the production of straw pulp has found its widest use in Italy. In fact the use of straw for the manufacture of bleached pulp and paper had reached a higher state of development in Italy before the war than in any other country of the world. This development received great impetus under Mussolini's program of self-sufficiency during which time several modern bleached straw pulp mills were constructed with government assistance.

The monosulphite process is the most commonly used process in operation in Italy at the present time for the production of bleached straw pulp. There are at least seven mills which produce straw pulp by this process. The largest and most modern of these mills is the Ferrara mill of Cartiere Burgo. This mill was visited, and a rather good picture of this process in operation was obtained. The mill was built under Mussolini's broad self-sufficiency program. It is beautifully laid out with smooth flowing engineering lines, plentiful space, and ideal working conditions. Production is now about 25 metric tons per day of high quality bleached and unbleached straw pulp which is used in various grades of paper in other Cartiere Burgo mills.

The dry straw, after going through the complete preparation system is stored above rotary globe digesters. It is moved from storage bins to the digesters by means of screw conveyors, and the cooking chemical solution is added to the straw in a mixing and dosing chamber before the straw reaches the digesters. This

(*continued on page 48 A*)

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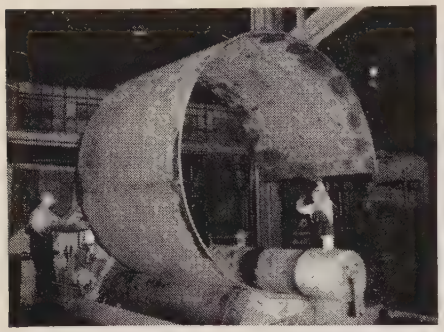
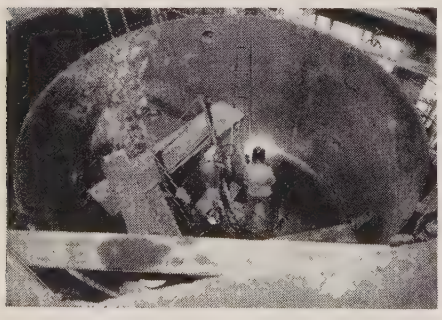
(1) This view shows the stainless steel clad plates from which the digester was made being marked from a templet.



(2) Plates being rolled to form the cylindrical shell. One longitudinal weld is already completed. The edges of the plates have been prepared for the welding of the other longitudinal seam.

(3) The inside seam connecting the bottom of the digester to the shell is welded. Stainless clad steel was used for making the digester.



(4) Two of the six sections being welded together at the pulp mill.

This Digester

has what it takes for pulp mill service

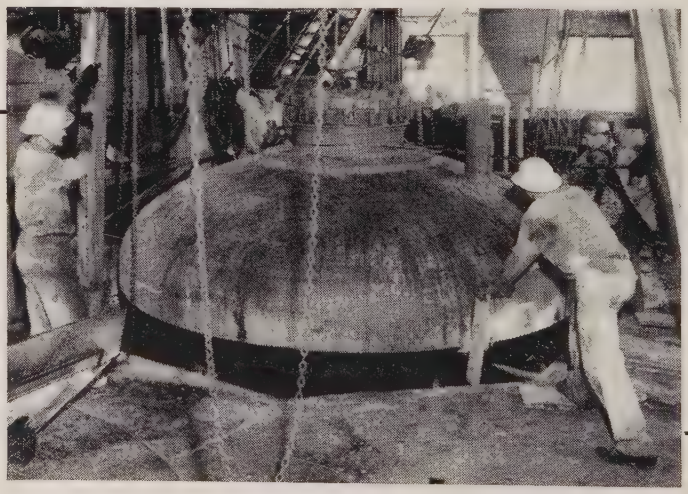
It's "tailor-made" to solve a corrosion-problem

The southern mill where this 12-ft. diam. by 33-ft. 1 in. sulphate digester is installed uses a hot caustic solution to make pulp from pine chips. To withstand this corrosive service, the digester is made of 10 per cent type 347 stainless clad steel. A second digester of similar construction was installed at the same time as this one.

It's "form-fitted" to solve an erection problem

Both this and its companion digester had to be erected *inside* an existing building. The problem was overcome by fabricating each digester in six separate sections in the shop. These sections were then assembled and welded in place in the field.

This installation demonstrates our ability to handle special as well as standard steel plate fabricating and erection assignments. The equipment we furnish the paper industry includes diffusers, spherical acid accumulators, pulp washing tanks, flat-bottom storage tanks, and elevated water tanks. We have special facilities for x-raying and stress-relieving pressure vessels according to code requirements. Prompt service to the paper industry is assured because of the strategic location of our five plants. The next time you need steel plate structures, contact our nearest office for an estimate on process equipment that "has what it takes."



(5) Top head being lowered into position. Shortly thereafter it was welded to the top of the shell of the digester.

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Houston, 2 . . . . . 2156 National Standard Building
Los Angeles, 17 . . . . 1550 General Petroleum Building
New York, 6 . . . . . 3324—165 Broadway Building
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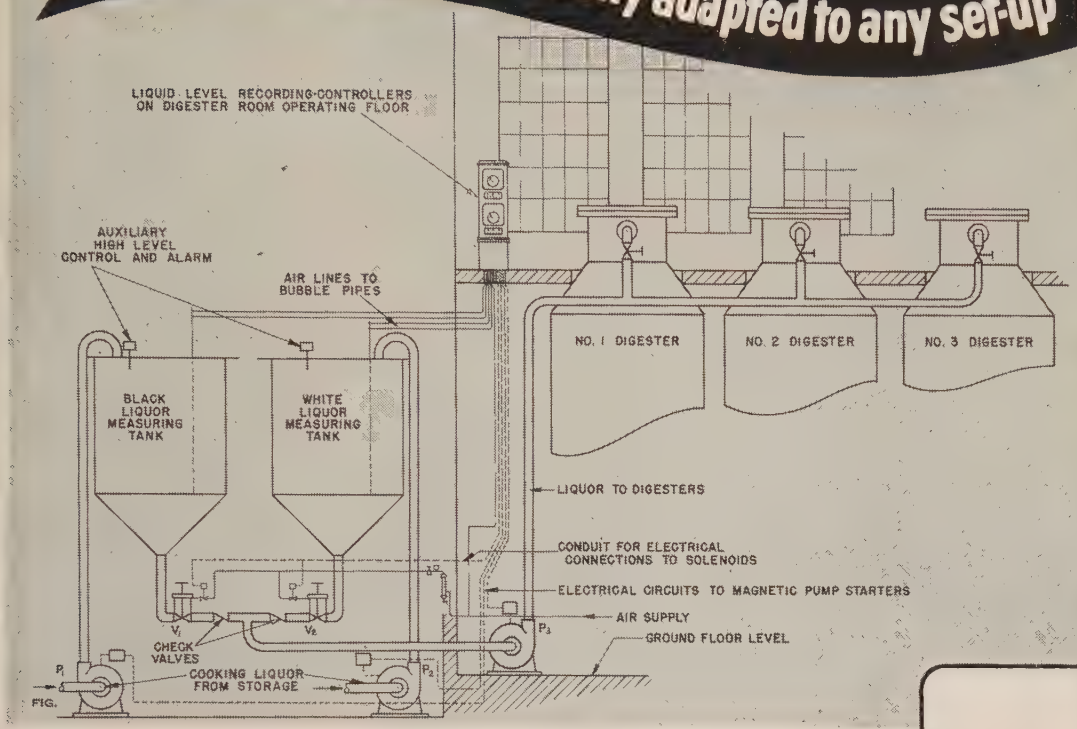

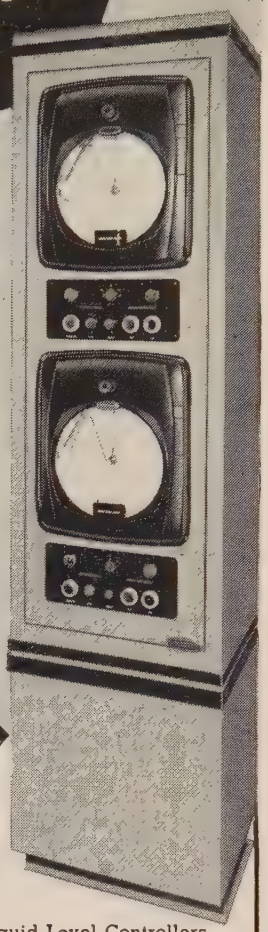

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Accurate, uniform charges of liquor to digesters can be depended upon, day in and day out, year after year, when this modern packaged control system is installed. The chart gives a permanent record of the amount of liquor used; improvements in product quality and uniformity show up almost immediately.

This control system is equally adaptable to set-ups having measuring tanks on the digester operating floor, on the ground floor, outside the digester building, or any other mill layout.

Your operators, too, will appreciate how easy it is to run this system. Merely setting a control index and pushing a button is all that's needed in normal operation. The Foxboro Automatic Digester Liquor Measuring System does all the rest — charges the digester and refills the measuring tanks.

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FOXBORO Reg. U.S. Pat. Off. **AUTOMATIC DIGESTER CONTROL**

(*continued from page 44 A*)

method of addition of chemicals provides for thorough mixing of chemical with the straw and allows complete filling of the digesters in one fill.

They use 10% sodium sulphite and 5% caustic soda based on the dry weight of the straw. The straw is then cooked for about 8 hours at 160°C. At the completion of the cook, the straw is dumped from the digesters, conveyed to washers, then over rifflers, screens, centrifugal separators, and thickeners. In all of these operations, more and more of the fines are either dissolved or washed away leaving good fibrous pulp.

The unbleached pulp is bleached with hypochlorite in Hollanders in a one-stage bleaching operation. Consumption of chlorine is about 5 to 5.2% based on the dry weight of the unbleached pulp.

The yield of bleached pulp obtained is approximately 42% based on the dry weight of the straw received. This is in contrast to yields of 50% which have been obtained in laboratory operations in both the United States and Italy by the monosulphite process. Some of this loss is due to the large amount of material removed in the complete straw preparation system, and no doubt additional loss in yield results from the use of caustic instead of soda ash to obtain the necessary alkaline condition. Thus far none of the mills in Italy have produced straw pulp on a commercial scale by use of the neutral monosulphite process developed at the Northern Regional Research Laboratory in the United States in which sodium sulphite and soda ash or sodium bicarbonate are used as cooking chemicals without the addition of caustic. The Italian mills claim that with the straw available, this process has not been satisfactory unless they used about 5% caustic soda. However, experiments along this line are in progress.

In addition to the mills in Italy, there are mills in both France and the Netherlands which contemplate installation of equipment for preparation of bleached straw pulp by the monosulphite process.

The Marsoni Process

The Marsoni mill at Villorba, Italy produces straw pulp and converts it into glassine paper in a completely integrated operation. This was the first mill in Italy to use straw for pulp and paper. They use a unique cold caustic process which requires a period of about 15 days to complete the reaction.

After preparing the straw in the usual manner, it is conveyed on a continuous basis through a dosing and mixing chamber where caustic soda solution is added in an amount equivalent to about 10% caustic on the dry weight of the straw. The wet straw is then carried by a long screw conveyor, during which time the caustic solution is almost completely absorbed by the straw, to large concrete chests in which the digestion process takes place. The straw, thus treated, is allowed to stand in these chests without agitation or heating for a period of approximately 15 days. It is then washed out of the bottom of the tanks by means of high-pressure water hose, conveyed to washers, screened, run through rifflers, and thickened in the usual manner.

Some of this pulp is used in the unbleached form for production of high quality glassine paper. Part of the pulp is bleached in a one-stage hypochlorite process, and the bleached pulp is used for glassine either alone or in combination with bleached sulphite wood pulp. It is particularly suitable for glassine paper because of the high hemicellulose content resulting from the extremely mild digestion process. Because of this slow, mild process the pulp is superior in quality and yield to the straw pulp produced by the more rapid processes, and the company has an excellent market for all of the glassine paper produced.

The Huguenot Process

A number of mills in France use the Huguenot process for production of straw pulp for corrugating board and for rough quality wrapping paper. This is a continuous process in which about 5% caustic soda is used based on the dry weight of the straw. The straw is fed continuously into the top of a tower at which point it is sprayed with the caustic solution. As the straw reaches the bottom of the tower, it enters a reaction chamber to which steam is added to heat the mixture to about 100°C. The reaction chamber is equipped with a slow moving agitator which keeps the high density straw in motion. This reaction chamber is a long horizontal cylinder, and the straw gradually passes from one end of the chamber to the other end allowing a reaction time of about one half hour at this temperature. From the reaction chamber, the straw is dropped into a large deep chest through which it moves slowly and from which it is discharged continuously after an additional reaction time of about 4 hours. No additional heat is added during its passage through this chest. At the end of this reaction time, the straw is sufficiently cooked for use in high-quality corrugating board or in rough types of wrapping paper.

The Celdecor-Pomilio Process

The Celdecor-Pomilio process is based on the original Pomilio process for continuous production of pulp from agricultural residues by means of caustic treatment followed by chlorination and bleaching. The Cellulose Development Corp. has obtained the world patent rights to the Pomilio process. The process and the design of the equipment used has been improved greatly during the past several years and it is now being used in many countries of the world.

As mentioned previously, the Cellulose Development Corp. has also obtained the patent rights to the Max Grumbach equipment for preparation and cleaning straw, and the design of this equipment has also been vastly improved.

Thus they are able to offer a complete line of equipment for straw pulp mills. They have at St. Paul's Cray, Kent, a complete small scale pulp mill which is used as a pilot plant for continuous production of 3 metric tons of high-quality bleached straw pulp. This plant has been used as a research installation for developing straw pulping processes on a practical scale, and the pulp produced is used in fine papers by an adjoining paper mill.

In the Celdecor-Pomilio process the baled straw is run through the straw preparation equipment as described previously. The clean straw is then fed continuously from the straw preparation plant to a dosing and mixing machine where the caustic solution is added automatically and continuously. Approximately 8% caustic

(*continued on page 50 A*)

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(*continued from page 48 A*)

based on the dry weight of the straw is added at this point, and the liquor is mixed thoroughly so that there is practically no excess liquor leaving the dosing chamber with the straw. From the dosing and mixing machine the wet straw is conveyed to the top of the caustic reaction tower by means of a screw conveyor. This tower is circular in shape and is about 60 feet high. The treated straw passes slowly down through the tower by means of gravity, and low-pressure steam is added along the walls of the tower. It is possible to reach temperatures as high as 130°C. in the lower part of the tower without having steam escape from the top. The bottom of this tower is larger in diameter so as to allow a longer digestion time without need of an excessively high tower. The cooked straw is removed from the bottom of the tower at a constant rate which can be regulated by the operator in accordance with the digestion time desired. Normally the digestion time, when preparing bleachable pulp, is about $1^1/_2$ hours, but much shorter time is sufficient if the semipulp is to be used for corrugating board or rough wrapping paper. The digested straw is conveyed from the bottom of the tower to vacuum filters on which it is washed free of cooking liquor. The semipulp is ready at this point for use in corrugating board and wrapping paper. If the semipulp is to be bleached, it goes from the filters to screen presses which dewater it down to about 25% moisture-free content. It is then run through an opening machine which fluffs the semipulp so as to expose a large surface area for the subsequent chlorination. It is then conveyed to the top of a chlorination tower which is constructed somewhat like the caustic reaction tower. As the semipulp passes down through this tower by gravity it comes in contact with chlorine gas which enters the tower through pipes around the wall. Since the surface area of the pulp is large because of its opened condition, the chlorine gas is taken up immediately and none escapes through the top of the tower. Consumption of chlorine in this stage amounts to about 18% based on dry weight of the finished bleached pulp.

The chlorinated pulp is removed continuously from the bottom of the tower and goes into a chest where it is diluted and run over a vacuum washer and thickener. The pulp is then subjected to an alkaline extraction process using 0.4% caustic based on the dry weight of the finished bleached pulp. This extraction is carried out at high density in a continuous manner. After leaving the caustic extraction tower, the pulp is washed again on a vacuum filter and run over coarse shaker screens to remove large particles such as nodes and grain from the straw. It is then run through rifflers or conical sandtraps at very low consistency where additional nodes, heavy dirt, etc. settle out, and finally through fine screens and vortraps to remove the finer dirt. Following the cleaning operation the pulp is thickened and run through a continuous hypochlorite bleaching operation in which about 3% available chlorine is used based on the dry weight of the bleached pulp.

By means of this process an excellent quality, clean bleached pulp can be produced from straw and other agricultural residues.

This company has had experience in 20 full scale plants in various parts of the world in which agricultural residues are being used. The most recent project completed is a new mill in Algiers. Cie Nord Africaine de Cellulose which is now in operation producing bleached pulp from esparto and straw and converting this pulp into paper in a completely continuous operation. Other mills are located in France, Italy, South Africa, Argentina, Chile, Uruguay, India, England, and the Philippines. Complete equipment for production of bleached straw pulp by this process is now being constructed for three French mills and for one in England.

In addition to the mills which use the complete Celdecor-Pomilio process, many mills use only parts of the equipment. One mill, visited in England, is using one caustic reaction tower for continuous production of about 35 tons of unbleached straw semipulp per day, which is used, along with waste paper, for the production of high-quality corrugating board. Another mill in the United Kingdom uses the regular rotary globe digesters for the caustic cook in a batch operation and the "Celdecor" chlorine reaction tower for the second stage in the production of both bleached straw and esparto pulp.

Pulp yields when using this process were found to vary considerably. One large mill which was constructed in Italy before the war by Pomilio was obtaining yields of about 40% of bleached pulp on the basis of the weight of the dry straw received. However this mill used the old type Pomilio equipment and operating conditions and they expect to get much better yields after completion of a modernization program which includes reconstructing their plant along the lines of the latest "Celdecor" developments. Other plants have reported yields of as high as 47% in commercial operations, and consistent yields of over 45% have been obtained for long periods of time in the pilot plant.

Although this process has found rather wide use it can be used to advantage only when certain conditions are satisfied. In addition to the normal conditions which must be satisfied when locating a plant, since this process depends for its chemicals upon the electrolysis of salt to form caustic and chlorine, the plant must be located near a source of low cost salt and low cost power. The process is based on the use of caustic soda and gaseous chlorine in the proportion in which these chemicals are produced from salt brine in an electrolytic plant. Thus in locations where cheap salt and cheap power are available the chemical costs are extremely low.

In view of the high state of development and the success of practical applications of the Celdecor-Pomilio process, it is believed that its use will be extended greatly in the future in locations where inexpensive sources of fibrous agricultural residues, salt, and power exist.

Other Processes

No doubt there are other processes or modifications of the processes described in use in Europe today but as mentioned earlier only those which were seen in operation have been covered. One operation, however, which should be mentioned although the plant was not visited, is that at the Thames Board Mills, Ltd. in

(*continued on page 52 A*)

KAOLIN CLAY FACTS ... *for Paper Makers*

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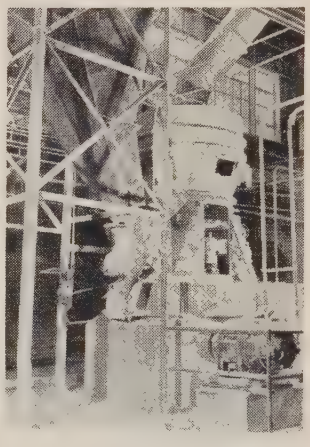
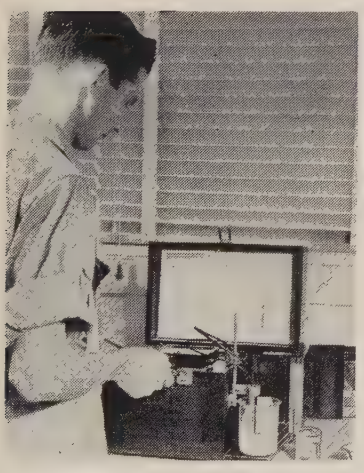
Huber Aerfloted Hi-White (Georgia)	15 mg
Huber Aerfloted Paragon (South Carolina)	16 mg
Huber Water Washed Filler (Georgia)	22 mg
Water Washed Filler "A"**	28 mg
Water Washed Filler "B"**	22 mg

*By the Valley Iron Works Abrasion Tester.
**These samples were obtained from mills using these grades regularly and are believed to be representative.



Air-flotation process takes place in a Raymond pulverizing mill with whizzer separator.

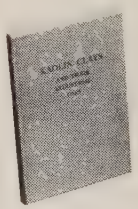


Determining the pH of clays at the Huber Clay Laboratory by a new high accuracy method.

CLAY CONCENTRATION HAS MARKED EFFECT ON pH VALUES, HUBER RESEARCH STUDY SHOWS. Using a method for the determination of pH values which is far more accurate than the conventional method, technicians in the Huber Clay Laboratories have discovered that pH values drop sharply as clay concentrations increase.

% Clay Concentration	pH
5	5.60
10	5.30
15	5.10
20	4.90
25	4.78
30	4.75
35	4.75
40	4.75

Coating clays, unless chemically treated after production, range in pH from 4.3 to 5.5. The pH of filler type washed clay is about 5.0. Air floated clays, depending upon the nature of the crude, range in pH from 4.5 to nearly 7.



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ONE OF THE WORLD'S LARGEST CLAY PRODUCERS

(*continued from page 50 A*)

England. They use Morley continuous digestion equipment for the production of about 20 metric tons of straw semipulp for use in board. In this process the straw is treated with about 6 to 7% caustic and passed through stationery tubes by means of a screw conveyor, adding steam along the tubes. The tubes are about 30 feet long and 2 feet in diameter, and the straw is run through two or three of these tubes depending upon the extent of cooking desired. It is claimed that an excellent semipulp is being produced by this process.

COOPERATION OF UNITED STATES AND EUROPEAN INDUSTRY

Before closing, the author should like to add that there has been in Europe a considerable amount of interest in the mechano-chemical process developed at the Northern Regional Research Laboratory. All of the research and development laboratories and the companies interested in straw pulping in Europe are well aware of the excellent work which has been done at the Peoria Laboratory and many of them asked a great number of questions about it.

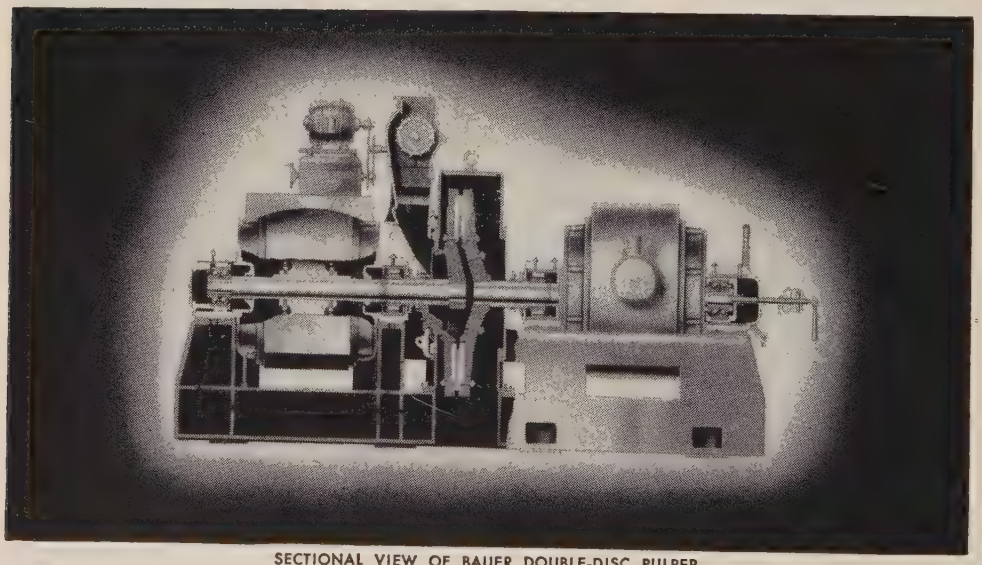
Before going to Europe the author spent some time with Messrs. Lathrop and Aronovsky discussing all of their recent development work on straw pulping. Also discussed were new developments in the industry with the pulp and paper staff at the Forest Products Laboratory in Madison, Wis., and the Institute of Paper Chemistry in Appleton, Wis., and all of them were extremely cooperative and helpful.

Because of the particular interest in utilization of hardwoods and straw, before visiting the mills in Europe, summary reports on developments in the use of hardwoods and in the use of straw by the United States pulp and paper industry were prepared. These reports were given wide distribution in the European industry and were translated into several other languages by the pulp and paper associations of the various countries for publication and further distribution.

In return for this information and other information passed on to the European mills, they were extremely cooperative in furnishing the author with complete information regarding their operations, processes, and plans.

This excellent cooperation on the part of both the American and the European pulp and paper industry has made the ECA work much less difficult and has been gratifying indeed. It has been by just such an exchange of information and ideas that the pulp and paper industry has made such great strides forward. It is firmly believed that complete exchange of technical information of the industry on an international basis will lead to even greater future progress in the pulp and paper industry of the freedom-loving countries all over the world.

RECEIVED Jan. 9, 1950. Presented at the Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 20–23, 1950.



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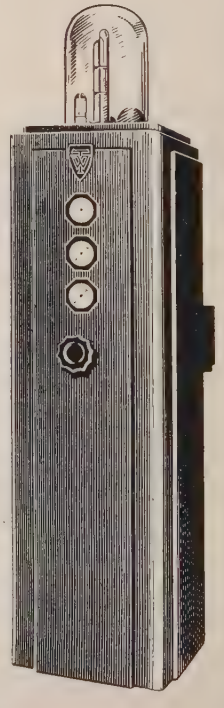

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I-29

Power Requirements for Paper Machines

First Report on an Electrical Engineering Committee Project

A. S. GOODRICH

With the development and application of sectional electric drives for paper machines, power required for each section can readily be measured. Some of this information has been published in *Technical Association Papers* previously; see references. From these data constants of power required per inch of width of wire and per 100 feet of speed per minute have been recommended for use to estimate the power required. These constants cannot be considered rigid because corresponding sections of similar machines on similar weights and grades of paper show a variation of 2 to 1. Similar or larger variations on an individual section of a machine on the same grade and weight of paper have been noted. The trend in paper machine design is for larger and faster machines making a wider variety of products. Sections for special treatment of the paper have also been added. Nip pressures of press sections are being increased. Data from modern machines installed during the past 10 years have been obtained and used to check or revise the constants. Data for cylinder and tissue machines have been included. Not only are recommended power constants for the various sections of paper machines listed but some of the unusual or special cases that affect power requirements also are described.

THERE is a continuing need in the industry for information on the power requirements of the individual sections of paper machines. Such data are valuable in checking the performance of existing paper machines, in pointing the way to improvements in their design, and in the application of new drives, both lineshaft and sectional.

It is the purpose of this paper to report on the power requirements of fourdrinier machines, cylinder machines, and tissue machines. The latter are classed separately from general fourdrinier machines because of their distinctive differences in make-up.

The information presented is based on test data obtained over a period of many years, and represents a continuation of the study which was undertaken by the Association in 1926. See references.

Since the technique which was used to arrive at the information necessarily involves judgment and averaging, individual cases may differ considerably from it. However, it may be said that much of this information already has been of practical use for many years.

This report should not be regarded as final. Papermaking is dynamic and progressive. The conditions of design, installation, and operation of paper machines are continually changing. Therefore, the Electrical Engineering Committee urges all TAPPI members who can do so, to submit power data to it, in order that the power information given here can be kept under constant scrutiny and review.

A. S. GOODRICH, Chairman, Electrical Engineering Committee; Chief Engineer, Hammermill Paper Co., Erie, Pa.

To facilitate obtaining such data from those members who can readily furnish it, a suitable form will be prepared by the committee. It is planned to send it at regular intervals to those members who desire to cooperate. The committee will analyze such data and publish articles from time to time supporting or modifying the information given in this report, as required. Investigation should be made of all individual sections but especially those which operate under exceptional variable conditions such as the couch and the calenders, and drier sections which show large variations in power requirements. Investigation should also be made of sections added for special treatment.

Experience indicates that the power requirements for paper machines can be based on a horsepower constant per inch width of wire per 100 f.p.m. over the major portion of operating speeds. The use of such a constant may not be mechanically rigorous but it is practical and convenient. The term "Normal Running Load" (NRL) is used for the power constants which represent the running load to be expected under normal conditions and does not allow for felt or sheet tension. However, in paper machine operation some abnormalities must be successfully dealt with as the occasion arises in the interest of continuous production. For this reason, "Recommended Drive Capacity" (RDC), constants are also given which include an operating safety margin above the NRL constants. The meaning of these constants is explained below (see "Fourdrinier Paper Machines other than those Producing Tissue"). It should be noted that these constants do not provide for the high-starting characteristics peculiar to certain sections.

In the selection of units (mechanical or electrical) for driving individual sections of machines, it is recommended that the RDC constants be used. When a motor or a turbine is to be applied to a lineshaft drive, the situation is somewhat different since the effect of a local overload is considerably offset by the other section loads. Because of this diversity, it is recommended that the NRL constants be used to determine the required capacity of the lineshaft drive. The lineshaft and backstand losses should be considered. The over-all efficiency from the prime mover on the lineshaft to the section indriving shafts may be estimated conservatively as 85%.

FOURDRINIER PAPER MACHINES OTHER THAN THOSE PRODUCING TISSUE

Besides the data already given in previous TAPPI papers, listed under references, the performance of about 30 fourdrinier machines installed during the last ten years was considered. Included were: five typical newsprint machines varying in width from 160 to 236 inches and operating at various speeds from

900 to 1275 f.p.m.; 11 typical kraft machines varying in width from 130 to 240 inches and operated at various speeds from 200 to 1272 f.p.m. producing basis weight sheets (24 × 36—500) from 30 to 264 pounds; and 14 typical bond, book, glassine, and bristol board machines varying in width from 112 to 202 inches and operated at various speeds from 148 to 800 f.p.m. producing various basis weight sheets (24 × 36 —500) including 24½-pound glassine paper, 37 to 135 pound sulphite bond paper, 30 to 85-pound book paper, 33 to 56 pound rag content bond, 45-pound offset, and 135-pound bristol board.

From these operating data, the committee attempted to arrive at so-called power constants for the various machine sections. In line with previously accepted practice, it was believed that operating requirements could best be evaluated by establishing two power constants for each machine section: one constant, to be known as the Normal Running Load Constant (NRL) and the other to be known as the Recommended Drive Capacity Constant (RDC).

Normal Running Load Constant—(NRL)

It was the thought of the committee that the NRL constant should be based on the expected operating load of each section of the machine when operated under normal conditions such as normal vacuum conditions on the fourdrinier, normal nip pressures on the presses, zero tension in the sheet or felt entering or leaving the section, adequate bearing alignment, properly lubricated bearings, full roll calender stack, properly evacuated driers, etc. The estimate for the normal operating load of any particular machine will then be proportional to the sum of the NRL constants for the various machine sections comprising the paper machine.

Recommended Drive Capacity Constant—(RDC)

The second power constant, to be known as the recommended drive capacity (RDC) constant, is to represent the power requirements estimated for any particular section when operated at the maximum load to be anticipated. It is recognized that such maximum loads may be due to several causes such as: high vacuum on the fourdrinier suction boxes, condition of the suction couch roll, high loading or nip pressures on the presses, excessive amount of water in the driers,

Table I. Recommended Power Constants for Fourdrinier Paper Machines Other than Those Producing Tissue

	Recommended constants, hp./in. width/100 f.p.m. NRL	RDC
Couch		
Paper Classification		
A. Toweling and light wrapping	0.043	0.050
B. Glassine and bond	0.064	0.075
C. News, kraft, and book up to 1200 f.p.m.	0.064	0.075
D. News, kraft, above 1200 f.p.m.	0.086	0.100
Main Press Sections, Plain or Suction Type		
Pair of main rolls	0.0225	0.030
Top roll only	...	0.010
Dual press side rolls each	0.020	0.025
Top side roll	...	0.010
Smoothing Press—Marking Press		
Pair of rolls	0.009	0.012
Size Press		
Pair of rolls	0.015	0.025

Note 1. Recommended power constants for presses are on basis of a maximum nip pressure of 175 pounds per linear inch.
Note 2. Power constants for size press have been increased from 0.009 to 0.015 based on test data from presses individually driven.

	Recommended constants per dryer roll above 160 f.p.m., hp./in./100 f.p.m. NRL	RDC
Drier Sections		
60-inch diameter rolls	0.0018	0.0027
48-inch diameter rolls	0.0014	0.0021
42-inch diameter rolls	0.0013	0.0019
36-inch diameter rolls	0.0011	0.0017

Note 1. Power constants for a drier section should be based on the total number of drier rolls in the section including both paper and felt driers.
Note 2. Starting torque for break-away on driers equipped with plain sleeve bearings has been considered by electrical equipment manufacturers previously as 4½ times normal running torque as determined by the NRL constant. Some new machines built since the war and old machines rebuilt have required as high as 8 times NRL torque to start driers with plain bearings. For antifriction bearings starting torque of three times NRL torque is ample.
Note 3. The drier NRL power constants in the foregoing recommendations are based on either antifriction or sleeve bearings above 160 f.p.m. When sleeve bearings are employed below 160 f.p.m., the running load increases rapidly. The following multipliers should be applied to both NRL and RDC constants in estimating the operating power requirements interpolating as required

F.p.m.	*Multiplier*
200	1.00
140	1.26
120	1.51
100	1.80
80	2.16
60	2.54
40	3.04

Note 4. For cooling or sweat driers, due to the fact that water is frequently carried in the rolls, the power constants should be multiplied by 1.33.
Note 5. Cleaning doctors requires additional power per blade as follows: 0.00075 hp./in. width/100 f.p.m. based on a pressure of 1 pound per inch width which is approximately correct if there is no loading other than the weight of the doctor itself.

	Recommended constants, hp./in. width/100 f.p.m. NRL	RDC
Breaker Stack		
Pair of rolls	0.009	0.012
Calender Stacks—8 and 9 Rolls		
(Paper Classification, lb. (24 × 36—500)		
Up to 70	0.035	0.050
90	0.056	0.060
130	0.056	0.080
225	0.056	0.100
Above 225	0.056	0.120

Note 1. Starting torques for break-away on calenders equipped with plain sleeve bearings should be based on a torque equivalent to 0.15 hp./in. width/100 f.p.m. operating speed.
Note 2. The NRL constants for the calender sections make no allowance for placing tension in the sheet between the calender and the preceding section. The RDC constant for this section provides marginal capacity to permit carrying a tight draw ahead of the calender.
Note 3. A real water finish on paper materially increases the calender load and should be taken into consideration where any power calculations are involved. What little data as are available indicate a 50% increase in power.

	Recommended constants, hp./in. width/100 f.p.m. NRL	RDC
Reels		
(Paper Classification, lb. (24 × 36—500)		
Up to 125, except kraft	0.008	0.012
Above 125, except kraft	0.008	0.020
All kraft	0.008	0.020

Note 1. The NRL constants for the reel make no allowance for placing tension in the sheet between the reel and the preceding section. The RDC constant for the reel section provides marginal capacity to permit carrying a tight draw consistent with established operating practice for kraft, news, book, and similar papers. For roofing felt, blotting papers, pulp, and comparable sheets, the RDC constant may be reduced by 50%.
Note 2. Slip belt reels may require from two to three or more times as much power as above depending on the buildup of the roll since the drive unit runs at a constant speed and considerable power is lost in belt slippage.
Note 3. Combination constant speed and center wind reels require two driving units of capacity based on above constants.

Table II. Power Constants for Cylinder Machines

Common felt sections	*NRL constant hp./in. width/ 100 f.p.m.*	*RDC constant, hp./in. width/100 f.p.m. see Note 2)*
Cylinder molds (each)	0.018	0.010
Extractor press	0.007	0.010
Extractor roll	0.007	0.010
Return drum press	0.007	0.015
Return drum roll	0.007	0.015
Suction drum roll	0.007	0.015 (see Note 3)
Primary or baby press (weighted)	0.012	0.025
Primary or baby press (unweighted)	0.007	0.015
Suction felt roll	0.007	0.015
Wringer roll	0.007	(see Note 4)
Felt suction box		
Flat, 7 1/2 inch	0.019	
Round, narrow	0.004	
Main press	0.0225	See Note 1

Note 1. As described in the text to establish the RDC constant for the first main press: (a) When there are no helper drives, the NRL constant for the main press should be added to the NRL constants for the other common felt sections. (b) When there are helper drives, 50% of the NRL constants should be used for those auxiliary sections which are motorized and 100% of the NRL constants for those sections without helper drives.

Note 2. The constants are used to establish the size of helper drives on those common-felt sections ahead of the first main press as described in the text. The RDC constant for primary presses has more than the usual safety factor over the NRL constant to provide a liberal margin for felt tension load.

Note 3. When a helper drive is applied to a suction drum roll alone, experience has shown that the drive will be required to provide considerable felt tension by pulling some of the load of preceding sections, as well as driving the drum roll. For this reason, under such circumstances, a service constant of 0.025 is recommended.

Note 4. Not usually provided with a helper drive.

tight drier steam joints, misalignment or other mechanical difficulties, sheet or felt tension entering the section, and many others.

These constants are representative of power requirements as reported on one or more of the 77 paper machines considered in the survey.

Committee Recommendations

Since the survey of power data included a representative group of paper machines, the recommended constants are considered to be representative of present operating practice. Table I indicates both the NRL and the RDC constants recommended for the various machine sections.

Total Input to Machine

In calculating the total power input to the paper machine the friction loads of the various sections should be added together using the working loads on the calenders for the proper weight of paper and the running light load (no paper) on the reel.

The reason for considering the working load on the calender only is because that portion of the load resulting from sheet tension tends to unload the driers.

On the reel, practically all of the load is tension which tends to unload the calenders or the driers, therefore, only the running light load should be used.

In calculating the rating of single motor, turbine, or engine drives for back line shaft drives, 15% should be added for back line shaft losses, belts and gears; also, the input to the paper machine should be calculated for both maximum speed and minimum speed to determine the increase in torque requirement for low speed operation.

CYLINDER MACHINES

First Main Press

The wet end sections of cylinder machines, ahead of the first main press, are connected to it by a common felt. These common felt sections may be driven by the felt alone from the main press or, when helper drives are employed, by the felt and the helpers. The helper drives normally do not provide all the power to drive the common-felt sections since there must be some tension in the felt for papermaking.

The total load on the drive for the main press is made up, therefore, of its own press load plus the felt tension load. If there are no helper drives, the felt tension load will be equal to the sum of the NRL or friction loads (total power required) of the individual common felt sections. When a helper drive is used on any section, the load that section would impose on the felt is correspondingly reduced. In the interests of conservatism and because high felt tensions are sometimes needed for unusual papermaking conditions, the reduction in load on the felt from that section should not be esti-

Table III. Power Constants for Tissue Machines

I. Total Friction Load of the Wet End Including Yankee Drier

	Hp./in. width/ 100 f.p.m.
Maximum	0.12
Average	0.09
Minimum	0.07

II. Sections of the Machine

	Hp./in. width/100 f.p.m. *NRL*	*RDC*
COUCH		
Maximum	0.05	
Average	0.04	0.05
Minimum	0.02	

Note 1. Couch power requirements effected by number of suction boxes and vacuum on same; also, by the character of the sheet.

PRESS		
Maximum	0.03	
Average	0.02	0.03
Minimum	0.015	

Note 2. Up to 175 pounds per lineal inch nip pressure. 12-ft. diameter Yankee drier (pressure roll driven by drier). *See Notes 3 and 4 below.*

Maximum	0.06	
Average	0.05	0.07
Minimum	0.04	
12-FT. DIAMETER YANKEE DRIER (suction pressure roll individually driven). *See Notes 3 and 4:*		
Maximum	0.05	
Average	0.04	0.05
Minimum	0.03	
SUCTION PRESSURE ROLL. *See Note 3:*		
Maximum	0.02	
Average	0.015	0.025
Minimum	0.012	

Note 3. Up to 200 pounds per lineal inch nip pressure.

WRINGER ROLLS		
Maximum	0.02	
Average	0.015	0.025
Minimum	0.012	
CALENDERS		
Two-roll stack	0.010	0.012
Three-roll stack	0.017	0.020
REEL		
Maximum	0.008	0.01
Average	0.004	
Minimum	0.002	

Note 4. To determine the constant for the drive of the Yankee drier section other adjuncts, such as pressure rolls, felt driers, creping doctors and cleaning doctors, all of which consume power, must be considered. The couch load and the wet press load may be partly transferred by the carrying felt and should be considered.

mated at more than 50% of the NRL constant. This then will provide for a liberal-sized drive on the first main press to take care of felt load.

Helper Drives

The power required for helper drives on the common felt sections are not representative of their NRL or friction loads. Helper drives for cylinders usually are adjusted to furnish less power than their NRL or friction load to provide necessary felt tension to carry the sheet. Conversely, helper drives on primary presses usually are adjusted to furnish more power than their NRL or friction load to help the main press pull the felt. Usually, these adjustments aim at a generally increasing felt tension around the common felt loop from the cylinders, through the primary presses, to the main press. There may be variations in this general increase at particular sections, but these are not important to our report and are outside its scope.

In view of the foregoing a second set of power constants (RDC) is required to establish the size of the helper drives themselves in addition to the NRL constants to be used for the first main press drive.

TISSUE MACHINES

In normal operation the wet end sections including the Yankee drier are mechanically tied together through the felts. Total power input to the wet end is that required to overcome the friction load of the several component sections.

Power is usually applied at a minimum of three points: couch, press, and drier, and may be applied at as many as six or eight points. The distribution of the power input between the various indrive points is a function of the section friction loads and the amount of tension desired in the felt as dictated by operating requirements. Thus sufficient power must be available at the several driving points to permit the machine operator latitude in setting the tension in the felt.

The power constants listed are based on power readings taken on numerous machines in normal operation. They are submitted, and should be used, with the knowledge that they are general averages and that in individual cases lower values may be satisfactory or higher values necessary.

It is hoped that mills operating Yankee machines will cooperate with the committee to obtain data on the actual friction loads of the various sections which would permit a more precise approach in determining power requirements.

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DISCUSSION

P. J. Jerardi (The Black-Clawson Co.): The work which the TAPPI Electrical Engineering Committee is doing on the question of paper machine power constants is definitely a major contribution to our existing information on the subject.

For the majority of the constants, we are in agreement; the following are exceptions.

On a 210-inch fourdrinier on 50 pound kraft, running over 1200 f.p.m.—1321 f.p.m. to be exact—the couch constant calculated from operating data is 0.066. However, on this same machine, operating at 600 f.p.m. on 131 pound kraft, the couch constant is 0.081. In both cases, the flat box header vacuum did not exceed 7-inches. On the basis of this exception, it appears that additional data should be obtained to determine if a further breakdown of couch constants, beyond that shown in Items "C" and "D" is required, particularly for heavy weights at slower speeds.

One of the larger variables in power consumption on a fourdrinier is the flat suction box. The couch constants for the various grades of paper shown reflect the effect of the drag of the wire on the flat boxes, however, a further quantitative determination of the effect of the suction boxes should be made. From the foregoing, it is apparent that at least part of the increase in power is caused by increased suction box drag, even though the header vacuum is constant.

With reference to the drier constants, it has been our practice to use a 0.0014 for driers 36 through 60 inches diameter with a starting factor of 7. Actually, this value of 0.0014 with a starting factor of 7 is only slightly larger than the 0.0018 constant for the $4^1/_2$ starting factor.

Drier constants calculated for 60-inch driers, running at speeds from 600 to 1300 f.p.m., range from 0.00059 to 0.0011 for the wet end section where no help was obtained from tension in the sheet applied at adjoining section. We recognize that these values are very low and possibly the lowest that can be expected and that the effective steam joint load and water in the driers must not be overlooked.

Since the power required to rotate the steam joint is equal, if not greater, than the journal friction on a drier, consideration must be given to the type of steam joint used. The journal friction is a function of the drier diameter and increases in proportion with the diameter. The steam joint operates at constant torque so that increased speed means increased power. It then follows that for a given paper speed, the smaller diameter driers have greater steam joint loads. The sum of the friction and the steam joint load is fairly constant for the range of sizes, 36 to 60 inches in diameter. The fact that increased torque is encountered at low drier speeds was indicated in the first paper on the subject by Mr. Staege; yet published power constants after 1926 neglected to take into consideration that very important fact. We have found the tabulation of constants indicated as one of the references for this paper of prime importance and recommend that the new data be arranged in a similar manner so that maximum and minimum values may be analyzed.

Oversimplification of power constants should be avoided and all of the conditions affecting the power requirements of the machine sections should be evaluated.

Due to the fact that only when a machine with a mechanical drive is powered with a single motor, is it possible to evaluate the power required for each section. We have been unable to confirm as many installations as we would like. At the present time, we are gathering data on electric wet end helper drives on our most recent

cylinder machine installations and we will be pleased to cooperate with the committee in this important project.

C. G. Russell Johnson (Kimberly-Clark Corp.): I have compared the drive constants of Mr. Goodrich's report with our records on drives installed and operating. The constants listed in his report represent a sound and conservative starting point for selecting a drive. They also represent reasonable operating power requirements to check the mechanical performance of drive units. Periodically these drive constants should be revised. You plan to do this in your committee. Whether this revision should be a 5-, 6-, or 8-year cycle could be debated. I doubt whether more frequent revisions than every 5 years are necessary. More frequent revisions could be lost time and wasted effort.

When a drive is selected for a paper machine the machine itself is never an exact duplicate of any previous installation. The variables peculiar to the particular installation under consideration are too often far greater than any general constants that are available in the literature regardless of how current it may be. Why should we try to be too exact with general "constants?" A constant is only a general guide to mechanical performance. After any machine is once in operation and proper records are established for this particular installation, such records are more valuable as a guide to its continued top mechanical performance than any other available constant which could be arrived at by the compounding of synthetic coefficients or factors. It is assumed, of course, that when we establish such an "electric factor" that mechanical inspection of the equipment is maintained in order that the base or par so established is sound.

Quoting from the report, "Since the technique which was used to arrive at the information necessarily involves judgment and averaging, individual cases may differ considerably from it" and since any subsequent report necessarily would use the same technique to arrive at revised constants, my experience is that we should use such constants with this same judgment. Let's keep the information current and on the same basis that it will be used.

G. E. Clink, (Sandy Hill Iron & Brass Works): It was with considerable interest that I read the first report of the committee on "Power Requirements for Paper Machines." The attack on this problem is something which has been very much needed in the industry, and the report shows that considerable time and energy has already been put forth in the collection of data. The information presented and the method of presentation are excellent and the committee is to be congratulated upon its completeness.

Some points which I feel might require further discussion are listed below in the order in which they appear in the report.

1. Under "Recommended Power Constants for Fourdrinier Paper Machines": *Couch*—There is listed an NRL constant of 0.086 for news and kraft above 1200 f.p.m. with a recommended RDC constant of 0.100. This would indicate that there is something in the fourdrinier machine which increases the torque requirements at speeds in excess of 1200 f.p.m. Some data which we have collected show a machine operating on kraft below 1200 with a power factor of 0.0635 and another machine on which news was being made at speeds in excess of 1200 f.p.m. with the factor 0.678. It seems that these machines might have variables in themselves which would account for this amount of difference rather than the fact that one was going faster than the other. Therefore, I would like to hear further discussion on whether or not it seems desirable to increase this constant 0.018 by virtue of going over 1200 f.p.m.

2. The constant for a pair of main press rolls is given as 0.0225 as the NRL and 0.030 for the RDC. Under Note 1 of this heading, it mentions that the constants for the presses are on a basis of a maximum nip pressure of 175 pounds per linear inch. Our experience indicates that the constants on the basis of horsepower per inch per 100 f.p.m. vary as a straight line with the nip pressure with the constants, under some conditions, reaching 0.06. We would, therefore, like to suggest that as a part of this report, a graph of the power constants at various nip pressures be given. I believe that this is particularly desirable inasmuch as the tendency is toward higher nip pressure, and unless care is exercised, we will be in the position of furnishing a press drive inadequate for the job.

3. The report, gives recommended constants for drier rolls for several different size driers. It is noted that these constants are slightly higher than those previously published. It is our thought that the former constants are adequate. We have recorded instances of where the constants are only one half of those given. It is assumed that the machines from which these data were obtained all carry drier felts. It would be interesting if this same information could be obtained from several machines which do not carry drier felts. Our records show such a machine with a factor of approximately 0.006 and the same driers with drier doctors with a factor of approximately 0.0008.

It is interesting to note the comments which you give for machines running under 160 f.p.m. I might add that the machines from which the previous data were given were operating with journal bearings from 110 to 190 f.p.m. Our data also show a tendency for the power to go up under 110 f.p.m. but to nowhere near the extent which is indicated in the report.

We have also found by tests that the drier bearings lubricated with grease operate more efficiently than oil bearings at extremely low speeds.

4. Under "Total Input to Machine," we note that you recommend using the NRL constants for the determination of the total power on the machine, adding to this, 15 % for power losses. Whereas this seems reasonable, it would also seem that a certain amount should be added for starting unless it is felt that this is taken care of in the overload features of a turbine or motor. We also note that in the cylinder machine constants, only one factor is given. In previous data, one was given for plain bearings and one for antifriction bearings. We are wondering whether this was an omission or whether it has been found that there are factors other than bearings that determine the load on a cylinder machine.

Trends in Fundamental Research in the Cellulose and Wood Pulp Field

EMIL HEUSER

It would seem that one of the surest ways of keeping abreast of developments and perhaps even of recognizing what the future may bring is to review, as often as the opportunity arises, what has been done in the past and what is going on at present in the particular field of observation.

Let us see, then, what the trends are in fundamental research concerning cellulose, the primary building material of the pulp and paper industry.

To begin with the invisible, interest in the elucidation of the submicroscopic structure of the cellulose fiber appears to be unabated and, although enough enigmatic and contradictory observations remain to be clarified, it would seem that the knowledge which has been added during the last two or three years tends to diminish the complexity of this subject to some extent. Undoubtedly, this improvement of the situation is the result of the perfection of tools and methods, particularly where x-ray analysis and the use of the electron microscope are concerned. The latter instrument has helped much in filling the gap between the morphological structure, as seen under the light microscope, and the invisible fine structure, as derived from x-ray studies.

With the fibrillar structure of the fiber being definitely established, the main task of the electron microscope would now seem to be the further subdivision of the still more or less coarse bundles of fibrils into finer and finer ones, possibly and eventually down to the ultimate fibrils—that is, the individual filaments which may be looked upon as representing the individual chain molecules. Whether this ultimate goal can ever be accomplished, we do not know. As the matter stands today, the thinnest bundles which the electron micrograph reveals have diameters of as low as 50 A. and even less. Diameters of this order are comparable with those of the hypothetical micelles or crystallites, as derived from the evaluation of the x-ray pattern. The existence of such units is looked upon by some investigators as a justification for adhering to the micellar theory. In other words, it is thought that there is no further subdivision beyond these hypothetical micelles.

However, the most recent experimental evidence—as derived from metallic shadow casting, surface replicas, and electron stains (*1*)—would seem to be in favor of regarding the so-called micelles as being incidental rather than fundamental units. The dimensions of these units vary considerably, not only from one fiber type to another but also within the same type, depending upon the preparative techniques used for obtaining the specimens thin enough to permit examination (*1, 2*), as well as upon other special treatment given to the sample prior to investigation under the electron microscope.* Thus, vigorous mechanical disintegration, as accomplished by dry grinding in the very efficient oscillating or similar mills (*3*), or by the action of ultrasonic waves (*4*), particularly in combination with preceding partial hydrolysis (*5*), breaks down the so-called micelles into units of smaller diameters. The results of these observations seem to support the view that what we call micelles or crystallites are, indeed, incidental units of the fiber structure.

Viewing the original structure as a system in which crystalline or highly ordered portions of the chain molecules alternate with amorphous or disordered portions—that is, those in which the chains are less parallel and less tightly packed—we may well imagine that partial or so-called "limiting" hydrolysis would disperse or even remove the amorphous portions, whereas the crystalline portions remain. The length of these bundles of ordered chains could thus correspond to the length of the crystalline portions of the original fiber. Similar concepts are being expressed by various investigators, particularly by Roseveare and co-workers (*6*). That such views are more and more accepted may also be derived from a statement recently made by Mark (*7*), according to which the laboratory workers with P. H. Hermans are now engaged in a study of "the average *length* of the crystalline area" of various cellulosic materials by x-ray analysis. Putting it this way would seem to be quite helpful to those who feel that they would like to detach themselves from the original inflexibility of the micellar theory.

The understanding of the modernized concept may be assisted by including in our deliberations the possibility that cross linkages of primary valence character extend between the individual chains in lateral direction and that these are preferably located within the tightly packed crystalline regions. As long as such cross linkages remain unbroken, the splitting of the fibril bundles will be limited, and it is only when the cross linkages are broken down that the way is open for further subdivision.

Next to the attempts to clarify the issue of micelles vs. chain bundles of incidental dimensions, we observe undiminished activity in the attempts to find more reliable methods for determining the ratio between the crystalline and amorphous portions, not only as this ratio exists originally in the various cellulose fibers but also as it changes under various treatments and

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* Variations of this type may be expected to be reduced by the general application of the new method of sectioning fibers wtih the high-speed ultramicrotome (*2*).

during the preparation of synthetic cellulose fibers or like products. This ratio may be derived from a determination of either of the two portions in a given sample by chemical and physical methods.

The chemical methods which are based upon the rate of reaction—hydrolysis and oxidation, acetylation and the like—have been further improved: Nickerson's much-discussed hydrolysis method, by Nelson and Conrad (*8*); the periodate oxidation method of Mark and co-workers by Timell (*9*); and the heavy water (deuterium) exchange method of Mark and co-workers, which lies at the border between the chemical and the physical methods, by the original author together with Frilette, and Hanle (*10*). However, the chemical methods still suffer from a number of uncertainties. As the author has pointed out on previous occasions (*11*), it is not merely the physical state of the cellulose system which determines the rate of reaction. We must also consider the chemical reactivity which, for example, is different for the primary and the secondary hydroxyl groups and from which, therefore, interference must be expected. Then, there is the phenomenon of "recrystallization," which takes place when the determination of the rate of hydrolysis is the chosen method. The postulation of recrystallization of cellulose chain molecules during the early stages of hydrolysis with hydrochloric acid goes back to Ingersoll (*12*), who observed a sharp increase in the x-ray diagram of the hydrolyzed material, even after short treatments. This observation was more firmly established by Howsmon (*13*) and by Brenner, Frilette, and Mark (*14*), the latter using density measurements to demonstrate the increase in crystallinity. [Incidentally, both Howsmon's and Mark and co-workers' results show that the increase in crystallinity does not result (or does so only to a small degree) from the disappearance of amorphous portions, leaving behind a material which naturally would give a sharper x-ray diagram.] It is claimed that it is the recrystallization phenomenon which accounts for the fact that the accessibility values, as derived from hydrolytic treatments, are considerably lower than those which are derived from the physical methods. It will be interesting to see whether the elimination of the recrystallization interference by employing milder hydrolysis conditions, as observed by Battista and Coppick (*15*), will be confirmed by other investigators.

The physical methods, such as x-ray analysis (*16*, *17a*, *17b*) and density and moisture regain measurements (*13*, *18*, *19*, *20*), have likewise been improved. Although it is gratifying to learn that these so-called "nondestructive" methods lead to constant results if applied to the same sample (*7*), discrepancies between tests carried out by different investigators on different samples of the same type of fiber still exist. Thus, the amount of crystalline material reported by different investigators for native cotton, ramie, and flax fibers varies from 60 to 87%, that for rayon from 25 to 40%, and only that for wood pulps seems to show less variation—namely, from 50 to 60%. Since the amorphous-to-crystalline ratio responds to treatments of various kinds, some of the discrepancies could possibly be explained by variations which occurred when the samples were prepared. On the other hand, it is probable that the discrepancies will also be reduced by giving more attention to influences which, thus far, have been more or less neglected—for example, the size of the crystallites or the diameter of the chain bundles, the presence of accessible hydroxyl groups on the surface of the crystalline portions, and other factors which affect accessibility or crystallinity. In this respect, the critical studies of recent date by Frilette, Hanle, and Mark (*10*) on the heavy water exchange method and by Howsmon (*13*) on the moisture regain method show the direction in which research in this particular field will proceed.

One more point should be mentioned here—namely that, on certain treatments, such as dry grinding—part of the crystallinity is lost (*17a*) but may be restored by boiling in water or even by simply allowing the sample to stand in the airdry state at room temperature (*1*). The occurrence of these phenomena would suggest the possibility that such changes in the crystalline-to-amorphous ratio may also take place when wood pulp passes through certain stages of stock preparation and drying. A study of these and other manufacturing processes from this point of view may help to explain certain puzzling variations in reactivity and other behaviors of pulp, frequently observed in the mills.

Closely related to the submicroscopic structure of cellulose is its average molecular weight or chain length, and the study of this characteristic represents another important trend in fundamental cellulose research of today.

The most suitable method for establishing absolute values for the molecular weight or the average chain length of cellulose preparations would seem to be almost as much an open question as it was two years ago when this matter was discussed at a symposium in Appleton (*11*). Attempts to bring the results obtained by the ultracentrifugal techniques more in line with those obtained by other physical methods are being continued (*21*). Other progress made, using these techniques as well as the osmotic pressure method, have recently been reported by Svedberg (*5*) and by Mark (*22*). Light-scattering measurements (using nitrocellulose in solution) are being placed upon a more reliable experimental basis (*23*). Other investigators have studied modifications of the end-group assay method and have suggested either the use of dinitrosalicylic acid in alkaline solution and the colorimetric estimation of the resulting aminosalicylic acid (*24*), or the estimation of formic acid which under certain conditions is quantitatively produced from starch on its oxidation with periodic acid (*25*) and would probably also be applicable to cellulose (*26*). However, the discrepancy between chain-length values produced by different methods for the same sample of a cellulosic material is still considerable and may amount to as much as a few thousand anhydroglucose units. For a pure scientist, this uncertainty is rather difficult to accept. From a practical viewpoint, however, this drawback is not too serious, because any of the various methods will suit the practical purpose, which is to establish and to make use of the relationship that, for a given sample, exists between its average chain length and its physical properties. Considering the valuable information obtainable in this way, it is only natural that much of present-day research centers around this

relationship, including that part which, in this connection, is played by the chain-length distribution. Since much of this work is being done on wood pulp, we shall, though only briefly, return to it somewhat later.

Much other research, which likewise concerns the molecular structure of cellulose, is being done on the question of the presence or absence in cellulose of so-called "weaker bonds"—that is, of such primary valence bonds which are more easily split on hydrolysis or oxidation than are the normal β-1,4-glycosidic linkages which hold the individual units of the chain together in the length direction. Such weaker bonds may occur either at regular or irregular distances along the chains or extend in the lateral direction, in the form of so-called "cross linkages" between the chains. The idea expressed by Schulz and his co-workers in Germany some years ago that, in cotton cellulose, such weak spots occur at regular distances of 500 anhydroglucose units has found considerable support—e.g., by Kleinert and Mössmer (*27*) who eliminated such factors as waxy substances and the rate of diffusion which exert an undesirable influence upon the rate of hydrolysis. Münster and Haas (*28*) believe that proof for the presence of weaker bonds at regular distances may be derived from the occurrence in the chain-length distribution plot of cotton linters of more than 2 D.P. maxima. Schulz has supported his hypothesis through a study of the kinetics of the oxidation of cotton cellulose, dissolved in cuprammonium hydroxide, with air oxygen (*29*) and further support has come from the results of a similar study by others (*30*). It is thought that the oxidation results indicate the presence of a third type of weaker linkages—i.e., those which are cleaved at a rate that lies between the rates of the other two types. It would appear that the interpretation offered by these various investigators still involves much guess work. Questions about the nature of the weaker bonds and whether we are actually dealing with constitutionally different bonds or merely with such ordinary glycosidic linkages which are more readily attacked because of their location close to "foreign" groups—for example, carboxyl and carbonyl groups—are still as much in the realm of speculation as they were when they were discussed in Appleton about two years ago (*11*). The same uncertainty exists concerning the weaker-bonds hypothesis of Pacsu and co-workers who, it will be recalled, assume that, in cotton cellulose (surgical cotton), the ordinary β-1,4-glycosidic linkages are interconnected by acetal or half-acetal bonds at regular distances of 250 anhydroglucose units. It would seem that their latest publication (*31*), which deals with the kinetics of a heterogeneous hydrolysis using hydrochloric as well as organic acids, has not changed the situation (*32*).

In contrast to the hypothetical nature of cross linkages as part of its genuine molecular structure, we have those which may be introduced into cellulose either voluntarily or involuntarily. In view of the importance which must be assigned to the presence or absence of such bonds (*11*), we encounter continued interest in both the practical and the fundamental problems involved. This situation is illustrated by the much discussed action of formaldehyde upon cellulose, originally thought to be a means of introducing methylene bridges between neighbored chains, but in recent years having been explained in a different way (*11*). The results of work done at the Forest Products Laboratory in Madison by Stamm and co-workers (*11*, discussion, p. 47) with formaldehyde in vapor form on wood support the methylene-bridge explanation (*33*). So do the results of the study by Gruntfest and Gagliardi (*34*). In addition, the latter study demonstrates the possibility that, in the presence of much formaldehyde, simple methylene bridges are replaced by polyoxymethylene bridges; this leads to more stable, particularly more acid-resistant, fibers.

The latest study in this field, which resulted from the desire to avoid undue degradation of the cellulose, concerns the introduction of disulphide cross linkages into cellulose derivatives. The authors of this study (*35*) believe that this objective has been achieved in spite of the fact that a number of steps are involved which—like acetylation, tosylation, and certain oxidative after-treatments—have a more or less degrading effect upon cellulose. However this may be, the reactions involved are very interesting from a theoretical point of view and also because they seem to lead to fibers and films of peculiar and useful properties.

We should not leave the subject of cross linkages without recalling the interesting practical application of the oxidation of cellulose with periodic acid to wood pulp as a means of preparing therefrom paper possessing considerable wet strength. Schur and Levy (*36*), who did this work, believe that the resulting dicarbonyl groupings in the cellulose chains give rise to cross linking comparable with the effect of formaldehyde upon cellulose. What the authors mean, although they do not say so, probably is that cross linking is achieved by the reaction of one or both carbonyl groups in the periodate-oxidized chains with two or more hydroxyl groups of one or more unoxidized chains, thus linking two or more chains by way of ether linkages in a lateral direction, which results in an over-all stabilization of the entire chain system—i.e., the fiber.

The possibilities for cellulose to undergo reactions and to form derivatives would seem to be unlimited; this is attested by the keen activity of cellulose chemists in this field the world over. Obviously, we will not reach the saturation point for some time to come. This would seem to be particularly true if we become aware of the fact that a most promising field of cellulose research is just developing. This concerns the so-called "tracer technique," the usefulness of which has been compared by Calvin in his book on isotopic carbon (*37*) with that of the microscope, the spectroscope, or x-ray analysis. It means that, by "labeling" with radioactivity those elements or atoms of groups which we wish to introduce into cellulose, it becomes possible to trace the steps of the mechanism or mechanisms which are involved in the reaction under investigation. In addition, the tracer technique is being developed to furnish us with an excellent tool for throwing much needed light upon the synthesis of cellulose in the living plant by the assimilation of carbon dioxide, as well as of the so-called "bacterial" cellulose which certain micro-organisms synthesize from simple sugars in the laboratory. It does not need much of a prophetic gift to predict that cellulose chemistry will benefit

greatly from the use of this new analytical tool. The first publication, concerning the question of whether cellulose, when dissolved in sodium zincate, undergoes simple addition or forms an exchange compound, appeared some months ago (*38*). As far as can be seen from the abstract of this interesting but not easily accessible article, the reaction is one of addition compound formation, accomplished by hydrogen bonding and dipole-dipole attraction.

In the pulp field, fundamental research is, as would be expected, closely interwoven with its practical application. An illustrative example which, at the same time, points to one of the outstanding trends in pulp research, is the determination of chain length and chain-length distribution as a means of learning more about the inner chemical structure of wood pulp and the effect that this structure and subsequent changes will have upon the performance of the pulp when it is converted into various products, as well as upon the quality of these conversion products.

As in previous years (*39*), much attention is focused on finding an unobjectionable method of determining the average chain length of cellulose as it originally exists in the plants; this information would satisfy our scientific curiosity and would also enable us to assess, with some measure of reliability, the degree of degradation which the fiber suffers in its transformation into pulp. Both these considerations are behind the desire to know the original distribution of the chain length and how it changes during the various steps of manufacture. The task of obtaining significant average D.P. values from lignified plant materials is difficult, unless a method is found which permits the isolation of cellulose without degradation. No such method would seem to be available at present. Hence, we must resort to compromises. At the meeting of the American Chemical Society in San Francisco in March, the author reported on the more recent attempts in this direction and on the work done at The Institute of Paper Chemistry (*40*). The best compromise appears to be a mild method of sulphite pulping. This method, with subsequent conversion of the samples into their nitrates and the determination of the viscosities of the nitrates in acetone, yielded average D.P's. of 2300 to 2400 for sprucewood cellulose. These values are very close to those found by Bryde and Rånby (*41*), who used a similar method of cellulose isolation. Both sets of values are 400 to 500 points higher than those previously reported by various investigators, their values having been recalculated for the sake of comparison. However, they are still much lower than those obtained by using ultracentrifugal techniques, which approach values as high as 9000 (*42*). Even if these very high figures are decreased somewhat by the application of certain corrections to the experimental data (*11*, *21*), the discrepancy between the results from the two methods would still be considerable. Since, as indicated earlier, this great discrepancy is still not sufficiently explained, we are unable to say whether the average chain lengths of cotton and wood cellulose approach each other closely, as some investigators are inclined to believe, or differ from each other considerably, as would seem to be more probable. The clarification of the matter becomes still more difficult when it is realized that the values for cotton, even if determined by the same method—i.e., from the viscosities of their nitrates in organic solvents and calculated by using similar expressions for the viscosity–chain length relationships—vary by several thousand units. Thus, the cotton which we studied had an average D.P. of 4000, whereas Berkley and co-workers (*43*) have reported 10,000 to 11,000 for their sample (not recalculated). Both samples were from different sources, but had been grown with much care and taken from the bolls prior to opening, so as to eliminate degrading atmospheric influences as much as possible. Thus, the differences would seem to result from the impossibility of avoiding such influences to which cotton is very sensitive (*43*), or they exist with samples from different strains, places of growth, etc.

As regards chain-length distribution, we may be somewhat more positive, although much is still obscure. Our experiments, using the fractional precipitation technique, leave no doubt that cotton cellulose, even if protected against degrading influences, is rather polymolecular although short-chain material up to a D.P. of about 1400 is absent. It would seem to be this lack of short-chain material in cotton cellulose which distinguishes it most characteristically from wood cellulose. Although part of the short-chain material present in the isolated wood cellulose preparation undoubtedly results from degradation during the isolation procedures, another measurable portion would seem to be an original and fundamental constituent of celluloses from wood. The presence of this short-chain material is mainly responsible for their more pronounced polymolecularity as compared with cotton.

Although the views expressed are shared by some (*41*), they are opposed by others (*39*). However, it would appear that statements such as "from reliable scientific results, it would appear that the molecular size of cellulose is very uniform" (*44*), must be taken with reservation. In fact, doubt seems to have been expressed by some (*45*). Apart from this, it might be well to recall the pronounced preference which nature expresses for variety over uniformity. In other words, it is probable that nature produces chains of varying rather than uniform length.

Concerning the changes which chain length and chain-length distribution undergo during the cooking process and the bleaching and purification procedures, it may be said that earlier results, although obtained by inadequate means, could, in general, be confirmed in our later studies. As an example, the average D.P. of the original spruce cellulose of about 2400 dropped to 1900 to 2000 during the Mitscherlich pulping process and to 1400 during a normal quick sulphite cook for papermaking. The homogenizing effect of the cooking process, which occurs at the expense of a drop in average D.P. and to which we had directed attention in our early studies, appears more clearly defined as a result of the use of improved techniques. Whether this homogenizing effect continues through the bleaching and purification procedures, would seem to depend upon the severity of the treatments given. Thus, with well-controlled multiple-stage bleaching and sufficient alkalinity (pH of 10 to 11.5) in the second stage—i.e., hypochlorite stage—very little or no new short-chain material is produced; some of it may even disappear. However, such material appears again during the alka-

line purification when degradation occurs through oxidation. This effect, it would seem, is rather difficult to keep at a minimum, even if special means [which are out of the question for practical purposes (*46*)] are employed. Similar but also different objectives are involved in the studies of Tasman and Corey (*47*), which deal with the application of a modified method of fractional precipitation to bleached sulphite pulp, and of Samuelson (*48*), who was interested in comparing the effects of bleaching and aging (of alkali cellulose), as well as of a second sulphite digestion upon the chain-length distribution of unbleached pulps taken at various stages of the sulphite pulping process. The results of the latter study furnish valuable information which is quite useful when employed as a guide in the manufacture of pulps for various conversion purposes.

Another important trend in fundamental and applied researches in the pulp field concerns the development of better methods for predicting the performance of a given pulp when put to actual use. In spite of the progress which has been made in analyzing a pulp sample for an ever-increasing number of characteristics, the knowledge derived therefrom—chain length and chain-length distribution included—often fails to permit reliable predictions, and special tests are required, which, in most cases, are closely adapted to the particular conversion process for which the pulp is to be used. Although a great deal of the work that is being done in the research laboratories of both the pulp manufacturer and the pulp convertor remains, for plausible reasons, unpublished, we find many publications from other sources, all of which indicate a lively and interesting activity in this particular field. As would be expected, most of this type of work deals with the testing of a pulp's suitability for the viscose (rayon and cellophane) process. A considerable number of the published investigations come from Europe, particularly from Germany and the Scandinavian countries. Because of the interruptions and delay which the exchange of the technical and scientific periodicals suffered during and after the war, some of these studies have become known in this country only during the last few years. We notice that continued attention is turned toward the influence of drying upon the swelling and absorption of the pulp—properties which are so important for its smooth performance during the subsequent mercerization, xanthation, and dissolving steps (*49*). The dissolving operation is followed by filtration, and it is this important step which causes the operator most of the headaches with which the making of viscose, it would seem, is still richly endowed. The question which is basic to a good suitability-testing method is: What makes a good and what a bad filtering viscose? In order to find a satisfactory answer, much information is being gained from renewed studies on the influence of the distribution of the alkali throughout the pulp sheets and of the amount of carbon disulphide employed in the xanthation step (*50–64*). In addition, the parts which are played by chain length and chain-length distribution (*55, 63, 65, 66*) and by the peculiarities of the morphological structure of the fiber would seem to be conceded a greater influence than heretofore anticipated. In this connection, the earlier recognition that the reactivity of a cellulose fiber may be greatly increased by mechanical destruction of its original biological structure (*67*) has led to an interesting technical application in the so-called "Kehlheim" process, in which cellulose fibers, after their mechanical disintegration, may be satisfactorily mercerized and xanthated in *one* step and in which the usual alkali requirements are much reduced (*57, 58*). The customary ideas about the influence of the hemicelluloses (i.e., noncellulosic carbohydrates) in the pulp upon its performance in the viscose process, so frequently discussed in earlier years, are undergoing some interesting changes. That those compounds (for example, xylan) are just as easily converted into viscose as cellulose has been known for a long time (*68*). In fact, it has now been found (*69*) that these compounds are xanthated at an even faster rate than the cellulosic constituent of the pulp and, thus, do not contribute to the filtering difficulties. They are objectionable because their presence in the pulp indicates that the original morphological structure was not altered to the desirable extent, as it would be if the pulp had been manufactured by more severe cooking, bleaching, and purification treatments. The newly developed methods of testing pulps for their suitability for viscose making appear to take care of all these influences, and the application of the results to pulp manufacture should be helpful in the attempts to produce increasingly better viscose pulps, not only from the customary wood species and using the customary cooking method but also from hardwoods and from sulphate pulps.

The same hope may be expressed with regard to those methods which have been developed for testing the suitability of a pulp for acetylation and similar conversion reactions. Such methods are essentially concerned with determining the so-called "haziness" and the incompletely reacted fibrous residues which are found in acetylation mixtures, particularly when wood pulp is used (*70, 71, 58**). What constitutes the particles causing the haziness is still a matter of dispute, inclusive of haziness resulting from the use of alkaline-cooked pulps (*72*). The haziness problem was also discussed in its various aspects at the Madison, Wis. conference of the TAPPI Fundamental Research Committee in August of last year (*73*). If haziness were caused by the resistance of the primary cell wall of the fiber toward reagents or by some other "morphological" resistance, it is possible that thorough mechanical disintegration, prior to acetylation, would have a similarly favorable effect as has been claimed for the Kehlheim process for viscose manufacture. The fact that acetylation of cellulose in phosphoric acid solution (*74*)—i.e., in a system in which the destruction of the original morphological structure is accomplished by chemical means—proceeds at a faster rate than in the heterogeneous system would seem to support such assumptions.

Further clarification of the influence of the noncellulosic carbohydrates upon the performance of pulps for conversion purposes will undoubtedly come from the revival of the chemistry of the hemicelluloses. This revival is indicative of another important trend in pulp research, and we notice the progress that is being made in its various phases—in the isolation of the hemicelluloses from wood and wood pulp, their fractionation, the quantitative determination of their constituents, the

* The last reference includes determinations based upon heat evolved during acetylation and upon degree of substitution.

distribution of these constituents in the cell walls, their chemical or nonchemical relationships to the other wood components, and similar problems—as well as in the further elucidation of the role which the hemicelluloses play in papermaking. L. E. Wise (*75*) has compiled the results of the interesting and important accomplishments of recent years (including those concerning holocellulose), many of which can be credited to his and his co-workers' activities at The Institute of Paper Chemistry. In addition, we may refer to the publications of Haas (76) and Sitch (*77*) on the fractionation of holocelluloses, as well as to those of Jayme and Mohrberg (*78*) who, among other things, deal with the question of the existence of chemical bonds between the holocellulose constituents and lignin, and of Giertz (*79*) and Ratliff (*79*), who discuss the effect of the hemicelluloses upon the physical properties of paper.

In addition to the main trends, which have been pointed out above, we notice a number of limited activities—limited either because (1) interest has shifted away from some of the older problems and has turned to new objectives, (2) the problems involved would appear to be solved, or (3) these activities have not yet reached the stage at which they could be recognized as actual trends. Thus, we find that the interest of the research chemists in partial hydrolysis prior to alkaline cooking, which was so much in the foreground some years ago (*80*), has diminished. On the other hand, its commercial application, as a means of producing rayon pulp by the alkaline cooking processes in this country, particularly from hardwoods, undoubtedly significant and would possibly form the nucleus of a new trend.

Perhaps this may hold true also regarding the old problem of continuous cooking, the interest in which has come to life again and today manifests itself in pilot plant studies and commercial trials, particularly in Sweden by Johan Richter and the Kamyr Corp. (*81*).

As regards the standing of our knowledge on the chemistry of the customary pulping processes, we encounter some excellent reviews but only a few special studies—e.g., sulphite pulping by Erdtman (*82*), with special studies by Samuelson and Westlin (*83*) and by George A. Richter (*84*), and sulphate pulping by Hägglund (*85*). In addition, Jahn (*86*) has summarized the principal new technical developments concerning these two cooking processes. These various reviews furnish much food for thought and, undoubtedly, will stimulate renewed research activity in the respective fields.

Before closing it would seem to be fitting to point to one of the newest technical developments in sulphite pulping—namely, to the use of magnesia base in the cooking acid. Here we have an excellent example of what may be expected from years of painstaking research in which both the chemist and the engineer have participated. The new Weyerhaeuser plant in Longview is an eloquent example of an accomplishment through such co-operation.

The fact that the pulp and paper industry approaches problems like this and brings them to a satisfactory solution would seem to be of all trends the most important one. It is this spirit that urges us ahead—or to use a quotation: "Unlike the pioneer, the research worker cannot hope to reach the Golden West and rest from his labors with his task accomplished. The frontier of research is boundless."

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Adaptation of the B.O.D. Test to Pulp and Paper Mill Wastes

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Uses, advantages, and shortcomings of the B.O.D. test are discussed in relation to its use in respect to pulp and paper mill effluents. Recommendation regarding modifications and application to specific pollution problems is made and results of oxidation rate tests made on several pulp and paper mill wastes by this method reported and compared to the established rate for sanitary sewage. The rate of oxygen consumption by aerobic decomposition of various types of fiber is compared and data concerning the effect of fiber on long time B.O.D. rates are presented.

The use of the B.O.D. test for a wide variety of industrial wastes has lead to considerable criticism of the accuracy and in some cases the question of its applicability. Some of the criticism is justified since the test is not applicable for all types of waste and has certain shortcomings. However, these limitations are true of almost all testing procedure for even so apparently simple determinations as moisture content are subject to limitations and must be modified in accordance with the character of the sample and other considerations.

The primary purpose of the B.O.D. test is to estimate the oxygen depletion which will occur in a stream on discharge of a given waste. Perhaps unfortunately, the standard test measures the quantity of oxygen utilized in five days. This period was selected for two reasons. The first is that in the case of sewage the rapid primary reaction is substantially completed in five days, and the second is that many streams in this country reach an ocean within this period of time. However, of considerably more value than the 5-day test is the establishment of a rate curve covering the period over which the oxygen demand of a waste is exerted in a stream based on the longest time of passage prior to the receipt of great dilution. For example, if a mill discharges into a stream which joins a large body of water after three days passage at low run-off, a knowledge of the 1, 2, and 3-day demands are of considerably more value in determining stream conditions than a 5-day value. In the case of sanitary sewage established rate curves can be applied so that if the 5-day value is known, intermediate values can be calculated with reasonable accuracy. This is due to the fact that sanitary sewage contains all the elements required for the maximum rate of biological oxidation so that most samples exhibit the same rate of oxidation.

This is not true of all industrial wastes and oxidation rates of many of them do not coincide with that of sanitary sewage. Hence, the rate curve of sanitary sewage cannot be universally employed and one must be established for particular wastes if possible. This is not practical in all cases since plant discharges often vary in respect to both composition and relative concentration of various constituents which have a marked effect on the rate of oxidation.

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Table I

Days	Sanitary Sewage	Paperboard Waste	Deinking Waste	Flax Pulping Waste	Combined Kraft Mill Waste	Combined Strawboard Waste	Stripped S.W.L.
1	30	31	30	31	32	22	23
2	54	56	62	59	57	69	41
3	73	74	78	79	76	82	58
4	88	89	91	91	90	86	75
5	100	100	100	100	100	100	100

Some of the factors responsible for oxidation rate variations are as follows: (1) a deficiency of nitrogen in the substrate, (2) a deficiency of phosphorus in the substrate, (3) the presence of chemical oxygen absorbents, (4) the presence of insoluble matter such as fiber, (5) the presence of substances inhibiting bacterial development, and (6) the presence of inadequate bacterial seed.

The first two of these can be considered together since they both concern deficiencies of elements necessary for maximum microbial activity. It has been well established that in order to obtain maximum aerobic oxidation rates a minimum ratio of nitrogen to organic carbon of 1 to 20 must be present in the substrate. It is also known that phosphorus must be present in small quantities but the minimum ratio is not as well established as it is for nitrogen. Unquestionably other elements are required but since only traces are necessary, sufficient concentration of them is generally present in water-waste mixtures.

The deficiency of nitrogen and phosphorus requirements of many pulp and paper wastes has been well established by Lea and Nichols (*1*, *2*) Sawyer (*3*), Tyler (*4*), Holderby (*5*), and others. Such elemental deficiencies are compensated for in the present standard method (*7*) by adding mineral salts to the dilution water. The major objection to this technique is that the results of the test may indicate a higher oxygen depletion rate than that actually existing in the receiving stream in which the ratio of nitrogen and for phosphorus to organic carbon may be below the minimum level. For this reason some workers prefer to employ stabilized stream water as B.O.D. dilution water. However, this method is not likely to be productive of results more typical of actual conditions since natural waters can vary considerably from day to day in nitrogen and phosphorus content and the stream water which has been stabilized by storage not be representative of the stream on the day the effluent sampled is discharged into it. The fact also remains that most natural waters contain sufficient nitrogen and phosphorus to allow maximum oxidation rates of reasonable pollutional loads (*2*, *8*). Because of this, diminished oxidation rates in receiving streams due to limited nitrogen and phosphorus are not common and the use of the supplemented standard dilution water is indicated. In Table I the daily percentage of satisfaction of the 5-day B.O.D. of a number of common pulp and paper wastes are compared with those for sanitary sewage as established by Theriault (*9*). In all cases seeded supplemented dilution water was employed for the determinations which are average figures of a number of samples obtained from different mills. The sulphite liquor employed was stripped of sulphur dioxide to eliminate substantially the chemical oxygen demand caused by this substance.

Examination of this figure reveals that the 5-day rates for paperboard mill waste, deinking waste, flax pulping waste, and combined kraft mill waste are substantially the same as that of sanitary sewage when seeded and supplemented dilution water was employed. Strawboard waste showed some deviation, the rate having decreased below that of sanitary sewage initially but increased after the first day to one greater during the second and third days and again decreasing on the fourth day. This may be due to the physical nature of the waste since the high colloidal sol content probably must be liquified before it becomes available for oxidation. Stripped sulphite waste liquor deviated from the sanitary sewage rate to a greater degree than strawboard waste. The initial lag exhibited by this waste is probably due to an inhibiting effect of combined sulphur dioxide and the high succeeding rate due to the very readily available sugars present.

It can be concluded from these figures that for all the pulp and paper wastes tested, the use of seeded and supplemented water yielded oxidation rates substantially comparable to that of sanitary sewage, hence represent maximum decomposition velocities that can be obtained under the conditions of the test.

Chemical oxygen absorbents such as sulphur dioxide exert an effect on the B.O.D. test since the oxygen consumed by them is included with that employed for microbial respiration. Many of these exert their effect in a short period of time and for this reason can place a shock load on a stream close to the point of discharge. For wastes containing such substances it is well to evaluate the chemical oxygen absorption as distinct from the biochemical in accordance with the procedure described on page 142 of "Standard Methods" which consists actually of a 15 minute absorption test run in a similar manner to the B.O.D. procedure.

Insoluble or suspended organic matter can exert a considerable effect on the long time B.O.D. rate curve

Table II. Oxygen Utilized in Five Days Per Gram of Pulp

Pulp concentration, g./l.	Groundwood pulp	Alpha-cellulose	Semichemical pulp	Unbleached sulphite pulp	Unbleached kraft pulp	Bleached kraft pulp
0.66	80	60	60	100	35	165
1.36	58	63	50	78	30	120
1.98	53	42	58	55	35	68
2.64	56	44	52	39	49	73
3.30	48	15	50	...	43	68
6.60	..	26	35	32	33	...

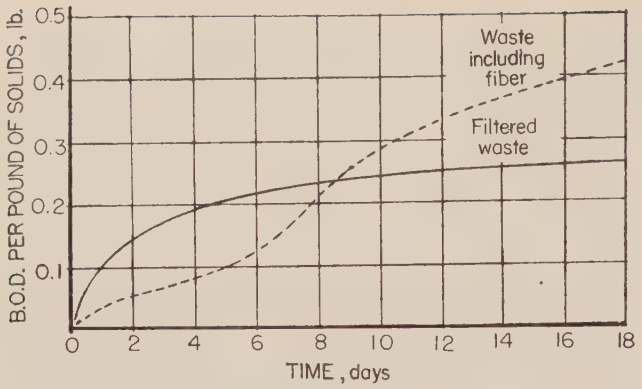

Fig. 1. Effect of added cellulose fiber on the oxygen demand of clarified board mill white water

since liquification of these materials must take place prior to their oxidation. Hence, the bulk of their effect can be exerted after 5 days of incubation. An example of this effect is presented in Fig. 1 in which pounds of B.O.D. per pound of solids for the dissolved and suspended fractions of white water waste are plotted against incubation time. It is obvious from these curves that the greater portion of the dissolved fraction is oxidized during the first five days of incubation and the greater portion of the suspended matter after five days.

However, it is evident that the fiber does exert an effect on the 5-day B.O.D. In order to evaluate the oxygen demand of fiber a series of B.O.D. tests were made on the common types of pulp by the "Standard Method" at different concentrations. The data obtained are presented in Table II. Examination of these figures reveals that pulp concentration in the substrate affects markedly the 5-day demand. The most interesting result is the observed variation between various types of pulp since the oxygen demand in no way follows the cellulose content and the bulk of substances other than cellulose present are believed to be quite resistant to aerobic decomposition.

Prior to use all samples received a very thorough washing with distilled water to remove adsorbed substances. Groundwood, semichemical, and unbleached kraft pulps containing approximately 35, 45, and 55% of alpha-cellulose, respectively, appeared to oxidize to about the same or a lesser degree than alpha pulp containing over 99%. Unbleached sulphite containing about 70% alpha-cellulose appeared to be decomposed faster than the alpha in lower concentrations but at about the same rate at higher concentrations. Bleached kraft of about the same alpha-cellulose content as unbleached sulphite was oxidized to a greater degree than any of the other pulps at all concentrations studied.

The variations are probably best explained by the presence of compounds other than cellulose or lignin, either naturally present in the wood or produced by treatment, which are readily decomposed aerobically, hence, influencing the results.

Seldom in determining the B.O.D. of pulp and paper mill wastes does the question of the presence of compounds inhibitive to bacterial activity arise. This is most fortunate since this is the most common cause of difficulty in applying this test to industrial wastes. Those inhibitions which have to be dealt with are either mild in effect as is sulphur dioxide and compounds containing it or are readily neutralized as is the case with chlorine or alkalies. The use of slime control agents in paper mills has never resulted in B.O.D. results indicating inhibition to the writer's experience or knowledge. It appears that the effectiveness of such chemicals is spent before the waters carrying them are discharged.

Seeding of synthetic dilution water with river water, sewage, or soil extract has become common practice in determining the B.O.D. of industrial wastes. This represents good practice in respect to pulp and paper mill waste for although most such wastes contain organisms capable of decomposing the organic matter present their numbers may be initially low and a lag occur before the development of a sufficient colony in the substrate to produce a normal rate of decomposition. The choice of seeding material has been the subject of some investigation (*4, 10*) and at the present time it appears that soil extract seed is most desirable for pulp and paper mill wastes. However, for routine mill testing purposes the writer believes that such refinement is not imperative and that any of the common types of seed will generally prove satisfactory.

The foregoing discussion serves to illustrate the application of the B.O.D. test to pulp and paper mill wastes and to point out some of the problems involved in its use. It is concluded that the B.O.D. test can be most useful in evaluating the pollutional value of these wastes when properly applied with an understanding of its limitations and intelligent interpretation of results. Research has gone far in recent years to improve the technique and expand the scope of its application.

While the dilution form of the B.O.D. test may be in time replaced in research laboratories with respirometer or manometric methods there is little likelihood of its being abandoned for routine deoxygenation investigations. Chemical tests have been looked to repeatedly because of their rapidity and reproductibility to replace the B.O.D. However, there is no reason to believe that any test can be found which is capable of measuring the quantity of respiratory oxygen utilized by microorganisms acting on selected constituents of a waste under natural conditions, and in a specific length of time by determining organic matter oxidizable under specific chemical and physical conditions. Since the B.O.D. can most closely simulate stream conditions, it will likely remain the best practical index of aerobic oxidation in surface waters.

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Construction of a Paper Mill

Some Engineering Aspects of the Tacoma Mill of the St. Regis Paper Company

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The engineering approach to the design and construction of St. Regis Paper Co.'s high-speed modern kraft paper mill at Tacoma, Wash., is stressed in this paper.

THIS paper describes and summarizes the paper mill engineering and construction work recently completed at the Tacoma, Wash., plant of the St. Regis Paper Co. Here a modern, high-speed kraft paper mill was designed, built, equipped, and put into operation in a period of less than 17 months. In a program such as this, engineering must be the watchword in order that proper coordination of the many phases of the project may result.

When we speak of engineering we usually think of the actual preparation of drawings and specifications from which the buildings are built, the mechanical equipment is ordered, and the installation is made. This very important phase of the engineering must be supplemented by other activities, engineer directed, so that the desirable end of having the right thing in the right place at the right time may be accomplished.

An important step is the early preparation of an equipment outline for distribution to engineering, purchasing, stores, accounting, and other interested departments. This outline certainly is not expected to be complete when first issued, but is set up in such a way that revisions may be made from time to time as additional requirements for equipment are developed. In this outline a system of numbering is used which is carried through the work on drawings, purchase orders, receiving slips, time reports, contractor's invoices, and finally on the accountant's plant ledger.

Having made the outline, the next step is to develop specifications for the equipment requiring longest delivery. This will require some preliminary design and layout work which is, of course, advancing. With the disposition of the long delivery items, certified drawings should be obtained from the various builders at the earliest possible moment in order that final plans of structures and equipment placement and hookup may be made. It is sometimes difficult to obtain such information all at one time, especially on such a large item as a paper machine. In the latter case the method was to tell the machine builder that the structure to house the paper machine would be designed and built starting at the winder and proceeding toward the wet end. He was, therefore, able to follow this order with his engineering and it developed that the machine room floor was finished through the driers before final information was at hand for the fourdrinier section.

Perhaps the most help was derived from a small scale floor plan drawing showing all three floor levels for the complete length of the 594 foot long building on which general studies of machine and equipment placement were made. The sections numbers, referred to in the outline, were labeled on all principal items of equipment.

Very valuable help was obtained from this drawing by use of transparencies or duplicate tracings. These were used for layout work on water, air, and other pipe systems; also for study work on illumination. In the preparation of detailed drawings great stress was laid on thorough coordination between divisions. Thus the pleasing effect to be noted on the ceiling of the paper mill building was the result of complete coordination of layout work between illumination, sprinkler, and ventilation engineers, each working in a different city but each keeping close watch on the other through exchange of plans giving a well-balanced and harmonizing installation.

Before going further into detail regarding design and construction, there was one factor which above all others was of incalculable help to the engineering of the project, and that was the appointment, even before the project was authorized, of the operating superintendent. The latter, by frequent conferences and diligent attention to detail, especially in the early stages, was able to suggest improved layouts and advance his own ideas to the very great gain of progress on the plans. Seldom was work done over because of lack of previous discussion with the operating heads. This procedure thoroughly demonstrated that the mill layout can be greatly enhanced by early and continuing cooperation between engineering and operating forces.

This particular project was engineered by groups of specialists working apart and somewhat widely sep-

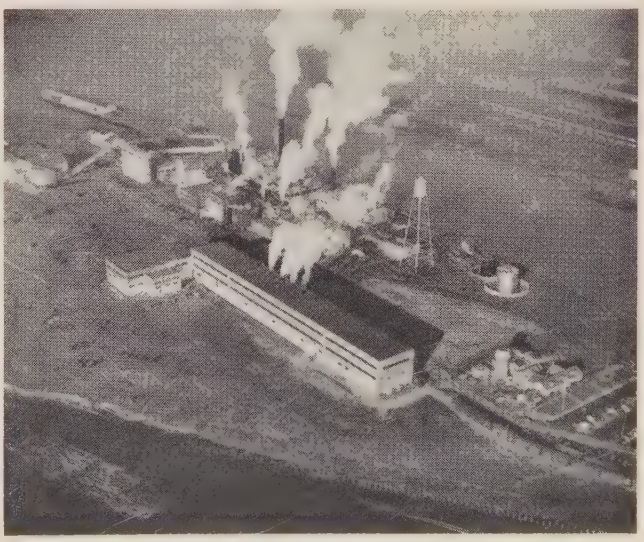

Fig 1. Aerial view of paper mill

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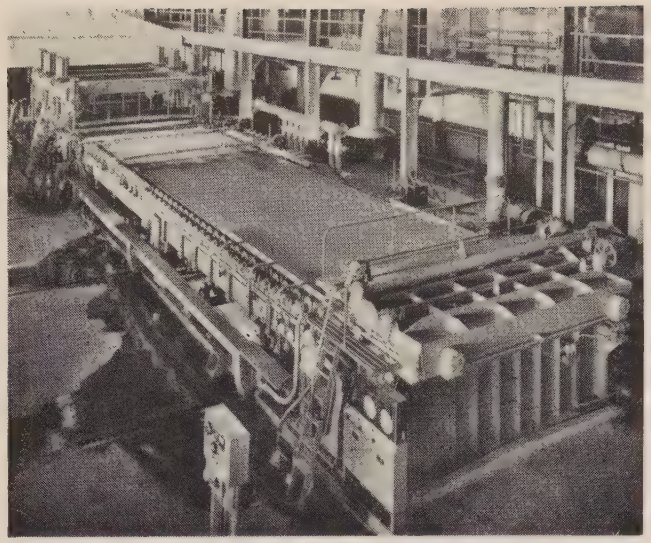

Fig. 2. View of wet end of machine

arated geographically. There was little or no paper mill engineering experience in the structural and layout group, the electrical group, or the piping and hookup group. These independent groups, however, contributed more in adaptability and freshness of viewpoint than perhaps an experienced crew direct from the paper engineering field could have produced.

The mill structure, which is somewhat unusual in design and appearance, is uniform for the length of the room, except in the basement, where variations occur because of the incorporation of tanks, chests, and pits for one function or another. The mezzanine floor, which with adjoining columns imparts horizontal stability to the superstructure, supports all the heating and ventilating apparatus, saveall, jordan motor control, and other equipment. It runs the full length of the structure. For a distance of about 260 feet from the couch pit to the end of the driers the main floor concrete structure is cut longitudinally by the press and drier pits. The problem of how to tie the two halves of the building together structurally became a matter of concern in case of shock from earthquakes. It was easy to conceive of a severe shake displacing the two halves of the structure so that they would not come back to their original position after the shake. Several earthquakes of minor intensity had occurred in the Puget Sound area in the past four or five years and the designers felt that every precaution should be taken to guard against permanent dislocations caused by shocks. The treatment finally used provided a 12-inch W. F. beam across the pit at each column point. This beam is so anchored into the concrete at each end that the full strength of the beam may be developed either in tension or compression.

Slightly over three months after the startup of the mill, on April 13, 1949, a quake of very severe intensity occurred imposing on the structure a test great in its magnitude of horizontal forces. A thorough check disclosed no dislocations indicating that both halves of the building remained in their original relationship to one another.

The point of this discussion of earth shocks and their effect is merely to stress the fact that henceforth, in the Northwest, designers of industrial structures, especially where precision highspeed machinery is installed, must take these severe shocks into account in their designs. As the quakes become greater in intensity or of longer duration, as the trend seems, this factor becomes even more important.

Reinforced concrete is employed for all structural purposes up to and including the machine room floor. Above that point is structural steel framework. The reason for the change in type of construction was that the heavy structural-steel sections which would have been necessary for framing for the paper machine were not available in 1947 for prompt delivery in 1948. The reinforced concrete structure was built with such speed that the steel superstructure was started three months after the first foundation was poured. Two months later the machine sole plates were being laid. This could not possibly have happened had a structural-steel framework for the machine track been employed.

The building has a precast concrete roof slab construction over which 2 inches of Foamglass insulation was laid, followed by an asbestos built-up roof.

The sidewalls above the machine room floor are of prefabricated Q-panel sandwich construction. This employs a square corrugated outside sheet and a flat inner sheet, both of protected metal, with $1^1/_2$ inches of Fiberglass insulation between. The sheets are interlocked at all edges to make a perfectly weatherproof joint. Instead of conventional windows, straight runs of corrugated wireglass are employed. The fasteners and all metal trim for this glass are stainless steel. The maintenance problem on windows is thereby eliminated.

MILL EQUIPMENT

The 180-inch paper machine is designed primarily for the production of multiwall bag paper at a maximum ultimate speed of 2100 f.p.m. There is no high headbox of the usual design. Instead, the stock mixture is kept under pump pressure while it is conducted through the flowspreader and on up into the inlet which contains perforated rolls and an elbow directing the flow horizontally to the lip of the slice. Here the mixture is spouted at wire speed and the sheet is formed.

An electrical panel controls the fan pump and its variable speed drive. A speed indicator on the panel shows wet-end machine speed. Two control instru-

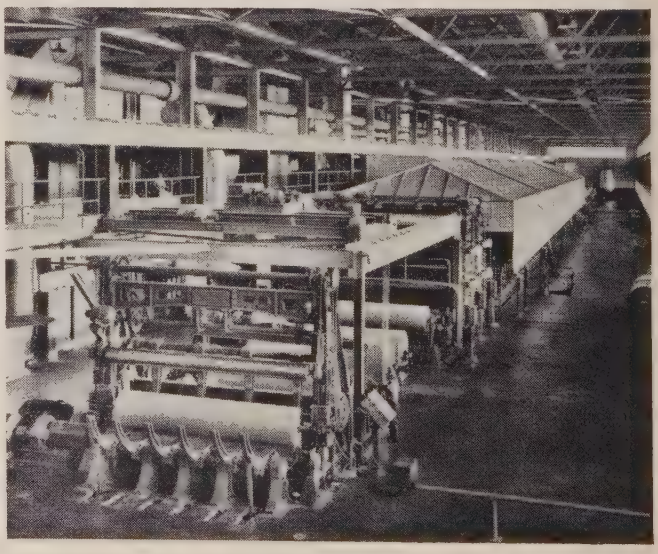

Fig. 3. View of dry end of machine

ments, adjoining the slice, indicate inches of head on the slice and the temperature of the wire pit water.

The wire on this machine is 120 feet long. The suction couch is 44 inches in diameter, has two boxes, and is served with two pair of H-11 vacuum pumps, each pair being driven by a 500-hp. synchronous motor. The Rapidrape system of wire changing is employed.

The press section consists of two 36-inch suction presses, each of which is served by an H-10 vacuum pump. Beyond the presses is a 42-inch lead-in drier equipped with a creping doctor. This is a separately driven section of the machine. Above the presses are cylinders for raising, lowering, and loading the top press rolls.

The drier part is divided into four sections, each separately driven and not mechanically interlocked. The machine has a total of 76 paper driers and 14 felt driers, all 60 inches diameter.

A very complete system of air supply units is installed for furnishing filtered and heated air to the room at roof level during the colder weather. This air—unheated—may be discharged near the work areas on the main floor during the summer months. Exhausting from the hood, are six fans discharging the drier vapors to atmosphere through vertical pipes extending through the roof. Other air systems include the calender blower system, trim disposal unit, d.-c. motor ventilating system, and two felt drier systems consisting of filters, heaters, fans, and distributing duct work. There is also installed a hi-jet air system for blowing hot air at considerable velocity into pockets in the drier section to aid in moisture removal.

Each oil supply line and each condensate line for the driers is equipped with sight glasses. There are approximately 430 oil outlets on the drier part—all supplied from a central system which consists of a settling and precipitation tank followed by a filter tank that contains the clean oil supplied by the pumps to the machine. Over 14,000 gallons of lubricating oil are required to fill this oiling system.

The winder is designed for a maximum speed of 4400 f.p.m. The 21-inch diameter winding drums are individually motor driven and the unwinding stand is equipped with electric regenerative braking.

The paper machine is powered with a sectional electric drive with electronic amplidyne speed regulation. The gear reducers are located on the inboard end of the d.c. driving motor shafts and the speed detectors, or tachometer generators, on the outboard end. The two units for the calenders are rated at 400 hp. each. The driving motors are force-ventilated by means of a supply fan and suitable ductwork which supply filtered air to the inboard end bell of each motor, the air exhausting at the opposite end.

Other components of the sectional drive consist of motor generator sets, amplidyne sets, and section control cabinets which contain the electronic amplifiers as well as the more usual control items such as relays, contactors, and protective devices. Two 1000-hp. synchronous motors drive the several generators, each of which in turn drives a section motor. Technical details of the drive are beyond the scope of this paper but the treatment of the control room is perhaps unusual.

All interior masonry surfaces of the control room were treated with glossy paint to prevent sanding and dusting of the masonry. The room is entirely enclosed and apart from the machine-room basement. To prevent infiltration of dust and dirt into the control room from the paper machine, a fan and filter are employed to furnish sufficient clean air to keep an outflow at all times. Louvres are located on both inside and outside walls at each end of the 180-foot long room so that the ventilating air may be delivered into the machine room basement or outdoors as desired. It has been found that the installation described has aided in keeping the equipment clean and therefore in good operating condition, with a minimum of maintenance. There are 33 rotating units employing commutators and brushes in this room. Conditioned air is therefore extremely desirable, not only for cleanliness of rotating parts but also to minimize dust deposits on the delicate control devices in the adjacent cabinets.

Broke may be handled directly into a hydrapulper by gravity feed from the end of the driers, from either stack, or from the reel. A large stainless steel hopper collects broke discharged through the floor openings in these locations and conducts it into the hydrapulper. Thus little broke is handled in the basement. The small amount to be handled may be thrown into the hydrapulper through a door in the hopper at the top of the ramp.

In the stock preparation system are located four concrete tile-lined chests for stock storage and for cycling through the system. The chest for raw stock storage contains about 50 tons of 5% stock. Two chests are used after the first and second jordaning, and the fourth chest, located near the paper machine, receives stock after the third jordaning and supplies the machine furnish.

A total of forty-two 8 and 12-inch two and three way valves were required for piping the 10 jordans. Class 100 Transite pipe was used for this piping as well as all stock and white water piping for the job.

One of the most advanced features of the mill is the continuous sizing systems. Here the proper mixture of raw size, and hot and cold water, is effected by means of a proportioning pump which is operated automatically by means of a float control on the emulsion tank. This trouble-free setup practically operates itself. The emulsion is discharged at a definite rate into the stock chest below by means of a rotameter.

The fan pump is rated at 30,000 g.p.m. at 40-foot head. Quantity and head may be varied over a wide range by means of a magnetic drive which is interposed between the synchronous driving motor and the pump. Stock is admitted to the pit water just ahead of the pump suction so that mixing is performed in the pump. No suction or discharge valves are used, and this arrangement has operated very satisfactorily.

Provisions were also made for a very complete paper testing laboratory, which is located in a constant temperature and humidity room conditioned in accordance with TAPPI standards. There are also facilities for analytical and other laboratory work in adjoining laboratories, thus insuring a uniform product under rigid control required for manufacturing a high quality of multiwall bag paper.

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Determination of the Exposed Specific Surface of Pulp Fibers from Air Permeability Measurements

JOSEPH C. BROWN, JR.

The exposed or external specific surface of pulp fibers plays an important role in the various properties of a sheet of paper. Since the fluid permeability method has been applied in other fields, its possible application to the paper industry has been investigated. The air permeability method, using a modified Kozeny equation, is feasible for the determination of the exposed specific surface of wood pulp fibers and handsheets. The pore shape factor appears to be constant over a wide range of porosity, whereas the Kozeny factor increases markedly with compaction. Values of exposed specific surface obtained by the air permeability method increase with beating. The area involved in fiber-to-fiber bonding appears to be negligible for handsheets prepared from an unbeaten pulp; for a pulp beaten to a Schopper-Riegler freeness of 610 ml. the area in fiber-to-fiber contact in the handsheets is increased to 25 to 30%.

THE exposed or external specific surface of pulp fibers plays an important role in imparting various properties to a sheet of paper. According to a widely accepted theory of sheet formation (*1*), surface tension forces exerted during drainage and evaporation of the water from a formed sheet draw the individual fiber elements close enough together to allow the fiber-to-fiber bonding forces to become operative. The exposed specific surface of the fibers affects the magnitude of these surface tension forces and also determines the area available for fiber-to-fiber bonding. Ultimately, however, the area actually used for fiber-to-fiber bonding is the more important quantity in controlling the optical and mechanical properties of the finished sheet and, perhaps, should be given greater consideration. That surface area of a fiber which is involved in bonding is no longer "exposed," but is masked by the contiguous fibers. Thus, a method of measuring the exposed surface area of the unconsolidated fibers in a pad, for comparison with the exposed surface area of the fibers in a bonded sheet of paper, should serve as a means of estimating the surface area utilized in fiber-to-fiber bonding.

The fluid permeability method for determining exposed specific surface has attracted considerable attention in recent years, particularly in the field of fine powders such as pigments and cements. In the basic Kozeny theory (*2*), which Carman (*3–5*) first applied to the determination of specific surface, the resistance to viscous flow exerted by a bed of granular particles is directly proportional to the square of the surface area in contact with the flowing fluid. For beds of rather fine particles, Lea and Nurse (*6*) noted that the resistance to flow of air or other gas was less than the resistance to liquid flow, and there was some doubt as to the validity of the fluid permeability method. Introduction of the concept of "slip" (*7*) when a gas is the permeating medium (see, for example, Loeb (*8*) for a discussion of the phenomenon of slip in cylindrical tubes) explained these divergent results at least in part, although Lea and Nurse (*9*) have stated that air permeability values still tend to be lower than those obtained by the liquid-permeability method.

The Kozeny equation as modified by Carman may be written

$$u = Q/A = [\epsilon^3/k_0(L_e/L)^2S^2\sigma^2(1 - \epsilon)^2]\,(\Delta p/\eta L) \qquad (1)$$

The list of symbols is given in Table I. The bracketed portion of equation (1), which may be called the permeability function, takes into account the size, shape, and mode of packing of the material composing the bed. The factor $k_0(L_e/L)^2$ is usually written as k. It is commonly known as the Kozeny constant, having an experimentally determined value of about 5 for beds of a number of granular materials.

To take into account the effect of slip of a gas past the surface of the pore walls, several modifications of equation (1) have been proposed (*9–12*). Differences in these modifications have been reviewed by Carman and Arnell (*13*). The modifications developed by Carman (*12*), when expressed in terms of mass rates of flow, takes the form

$$G = \frac{\epsilon^3 Ap(M/RT)\Delta p}{(1 - \epsilon)^2 kS^2\sigma^2\eta L}\left[1 + \frac{S\sigma(1 - \epsilon)k_0\eta(2/f - 1)\sqrt{\pi RT/2M}}{\epsilon p}\right] \qquad (2)$$

where the bracketed portion constitutes the slip correction. A convenient working form of equation (2) is obtained by substituting $h\rho g$ for Δp, and $P\rho_{Hg}g$ for p, where h is the pressure difference across the bed in centimeters of oil of density ρ, and P is the mean pressure in the bed in centimeters of mercury. Making these substitutions, equation (2) may be written

$$G/h = bP + c \qquad (3)$$

where b is

$$[\epsilon^3 A(M/RT)\rho g^2\rho_{Hg}]/[(1 - \epsilon)^2 k\eta LS^2\sigma^2] \qquad (4)$$

and c is

$$[\epsilon^2 Ak_0(2/f - 1)\rho g\sqrt{\pi M/2RT}]/[(1 - \epsilon)kLS\sigma] \qquad (5)$$

From a plot of mass rates of flow per unit pressure drop against the corresponding mean pressure in the bed, b and c may be evaluated. Under given experimental conditions, all factors in equations (4) and (5) may be evaluated except S, k, k_0, and f. The value of f varies slightly with the type of surface and for vari-

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Table I. List of Symbols[a]

In Consistent c.g.s. Units

A = cross-sectional area of bed, sq. cm.
b = experimentally determined constant for a bed, the slope of the line through a plot of G/h vs. P, g./(sq. cm. sec.)
c = experimentally determined constant for a bed, the intercept on the zero pressure axis of the line drawn through a plot of G/h vs. P, g./(cm. sec.)
f = fraction of gas molecules diffusely reflected from wall surface of channel, where $(1 - f)$ is the fraction specularly reflected
G = mass rate of flow, g./sec.
g = acceleration of a freely falling body, cm./sec.^{2}
h = pressure difference across bed, cm. oil of density ρ
k = Kozeny factor, dimensionless
k_0 = pore shape factor, dimensionless, a function only of the shape of the pore cross section
L = depth or thickness of bed, cm.
L_e = actual length of path taken by fluid in traversing depth, L, of the bed, cm.
M = molecular weight of permeating gas
P = mean pressure in bed, arithmetic average of bed inlet and outlet pressures, cm. Hg of density ρ_{Hg}
p = mean pressure in bed, dyne/sq. cm.
Q = mean volume rate of flow through bed, cc./sec.
R = gas constant, 8.316×10^7 (g./sq. cm.)/(sec.^{2} °K.)
S = specific surface of material composing the bed, exposed surface area per unit weight, sq. cm./g.
T = absolute temperature, °K.
u = apparent velocity, cm./sec.—that is, velocity calculated on empty container
W = weight of material composing bed, g.
Δ_p = pressure difference across bed, dyne/sq. cm.
ϵ = porosity of bed, fraction void space, where $(1 - \epsilon)$ is the fraction of solid material
η = viscosity of permeating fluid, poises
σ = density of material composing the bed, g./cc.

[a] Other symbols are defined in context.

ous gases (*14*); however, a value of 0.84 appears reasonable for air in cylindrical channels when the mean free path is less than the channel radius (*15*). Thus, there remain the three quantities, S, k_0, and k, which are to be evaluated from permeability data, but only two independent equations are available. If one of the quantities can be determined by independent means or can be assigned a reasonable value, the other two can be calculated. For beds of fine powders, it has been customary to assign a value of 5 to k, although the difficulty has been experienced that calculated values of specific surface of irregularly shaped particles are not then independent of porosity, but show a large and consistent increase with decreasing porosity (*9*, *16*, *17*). Various corrections which have been applied (*17–19*) to the porosity function, $\epsilon^3/(1 - \epsilon)^2$, yield varying results, none of which seem wholly satisfactory; Lea and Nurse (*9*) have suggested the possibility that k is not constant but increases with decreasing porosity.

This investigation is concerned with the application of the air permeability method to the determination of the exposed specific surface of wood pulp fibers, and of sheets of paper prepared from those fibers, with the object of evaluating the area involved in fiber-to-fiber bonding.

EXPERIMENTAL PROCEDURES

Variable Pressure Flow-Measuring Apparatus

In order to utilize to the fullest the effect of slip, flow measurements were taken over a range of mean pressures below atmospheric. The variable pressure flow-measuring apparatus, shown schematically in Fig. 1, is similar to that described by Rigden (*10*), with the addition of a recirculating air pump to give steady flow conditions. The apparatus was housed in a constant temperature room at 24°C. Air flows from the "high pressure" reservoir through the sample T, through one of the capillary flowmeters C_1 or C_2, to the "low pressure" reservoir. The rotary air pump R returns the air to the high pressure reservoir. In order to evacuate the system, the by-pass valves across the manometers are opened and the three-way stopcock S is adjusted to discharge to the atmosphere. When the desired vacuum is attained, the pump delivers to the high-pressure reservoir, and flow is regulated by means of the needle valve K. To increase the pressure in the system, air is slowly admitted through drying tube D_1. A silica gel drying tube D_2 and a tightly packed absorbent cotton filter F ahead of the sample assure dry clean air. Needle valve N is used only in conjunction with the sheet sample holder and will be discussed subsequently. Two capillary flowmeters are provided to permit flow measurements over a wide range of sample resistances. Capillary C_1 is 45 cm. long, with a radius of about 0.04 cm.; C_2 is 90 cm. long, with a radius of about 0.07 cm. The capillaries were calibrated in place by an oil displacement method at near atmospheric pressure, and a small slip correction was applied to obtain coefficients at the lower pressures. For beds of high resistance, mercury is used in manometer M_2, thus extending the usable range of the apparatus. Verniers on scales behind manometers M_1 and M_2 permit readings to 0.01 cm. Steady-state flow was maintained for at least 2 minutes before taking readings. Flow measurements were generally taken at bed mean pressures of 70, 60, 50, 40, 30, 20, and 10 cm. of mercury. The pressure drop across the bed was so adjusted that it was a small fraction of the absolute pressure.

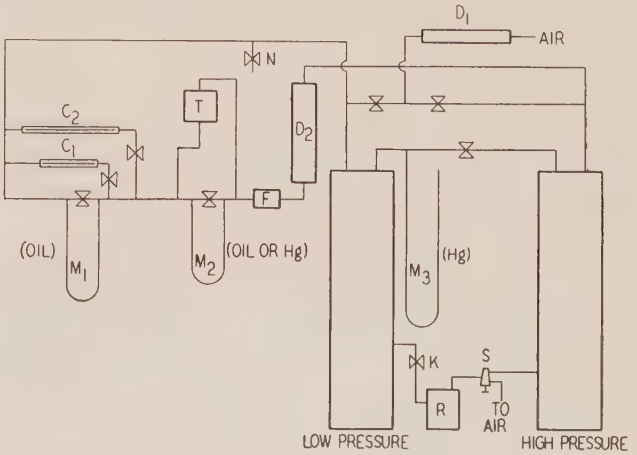

Fig. 1. Schematic diagram of variable pressure flow-measuring apparatus

T Sample holder
F Filter
D_1 Silica gel drying tube
D_2 Silica gel drying tube
R Recirculating air pump
S Three-way stopcock
K Needle valve
N Needle valve
M_1 Manometer M_1
M_2 Manometer M_2
M_3 Manometer M_3
C_1 Capillary flowmeter C_1
C_2 Capillary flowmeter C_2

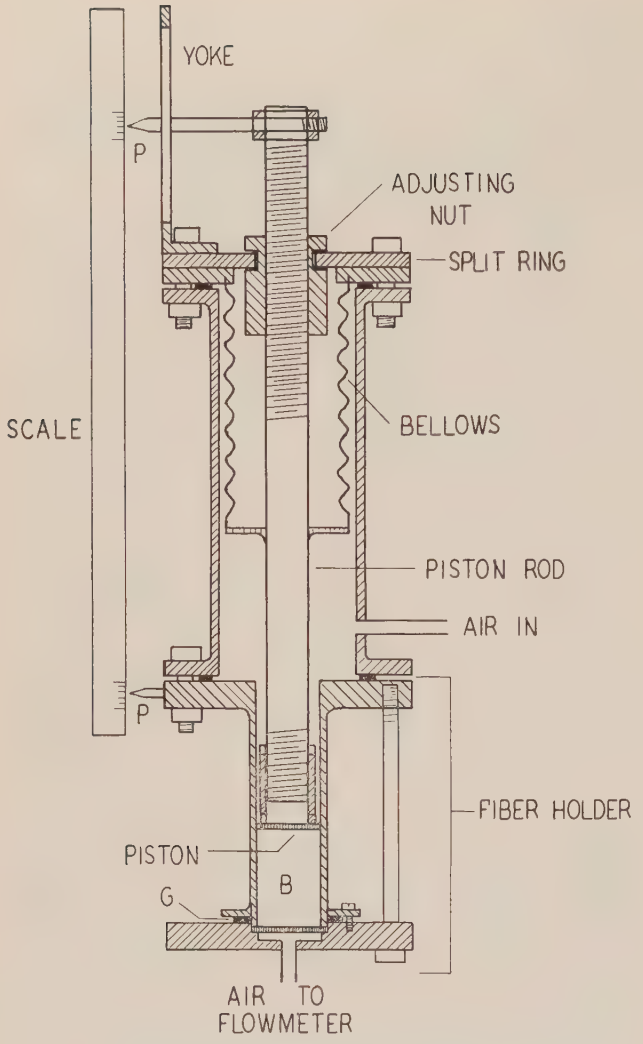

Fig. 2. Fiber sample holder and movable piston arrangement

For the beds tested, plots of the mass rate of flow per unit pressure drop against bed mean pressure were in all cases linear, with finite slopes, so that both equations (4) and (5) could be used in solving for S, k, and k_0. Mass rates of flow were calculated from the relationship

$$G = p_0 Q_0 \rho_{Hg} g(M/RT),$$

where Q_0 was obtained from the appropriate coefficient (Q_0/H) and the observed pressure drop H across the capillary flowmeter was employed. The mean pressure in the bed was taken as

$$P_2 + (\rho/\rho_{Hg})\,(H + h/2),$$

where P_2 is the pressure in the low pressure reservoir and H and h are the pressure drops across the flowmeter and the bed, respectively, in centimeters of oil. Similarly, the mean pressure in the capillary was taken as

$$p_0 = P_2 + (\rho H/2\rho_{Hg}).$$

Fiber Sample Holder

The sample holder for beds of loose fibers, shown in Fig. 2, utilizes the movable piston principle suggested by Fowler and Hertel (*20*). The piston is raised or lowered by means of the adjusting nut, which is free to turn in the split ring. The upper pointer P, which passes through the yoke, permits vertical travel of the piston rod but rigidly restrains its rotational movement, thus preventing damage to the Sylphon bellows which is soldered at its lower end to the piston rod and at the other to a ring bolted to the housing. This makes it possible to lower the piston rod through the housing while maintaining an airtight seal. The piston is threaded to the piston rod and secured by means of a lock nut. The lower periphery of the piston terminates in a number of projections $^1/_8$ inch square and $^1/_8$ inch long, to which is brazed a steel disk $^1/_8$ inch thick and drilled with $^1/_{16}$-inch holes on $^3/_{32}$-inch centers. To the lower side of this disk is spot soldered a disk of 40 by 60-mesh screen. The fiber holder proper is a piece of thick-walled brass pipe 4 inches long which is machined and polished to an inside diameter of 1.395 inches, giving a bed test area of 9.85 sq. cm. On the upper end of the pipe is threaded and brazed a $^1/_2$-inch steel flange from which the lower pointer P protrudes. The lower end of the brass pipe slips into a recess in a $^1/_2$-inch steel plate; it is supported in metal-to-metal contact by a disk of 40 by 60-mesh screen resting on an $^1/_8$-inch steel disk which is perforated with $^1/_{16}$-inch holes on $^3/_{32}$-inch centers, and is supported by a shoulder machined into the steel plate. A seal is assured by means of the annular gasket G, which is of soft rubber. The depth of the bed is obtained from the pointer separation by prior calibration, using a gage block of known thickness in the sample space B. The resistance to flow of the empty fiber holder was measurable, and was subtracted from the reading of manometer M_2 (Fig. 1) to obtain the pressure drop across the bed. To install a sample, the piston is raised and the fiber holder proper is unbolted from the upper housing. The loose fibers, which are in moisture equilibrium with air of 50% relative humidity at 24°C., are transferred in increments of about 0.5 gram. After each increment, a 750-gram plunger is gently lowered onto the bed, as an aid to formation of a homogeneous sample. When the desired quantity has been transferred, the fiber holder is assembled to the upper housing (dowel pins assure proper alignment) and the piston lowered into position. After connecting with the variable pressure apparatus, the sample is dried in place by passing a slow stream of dry air through it for at least 4 hours. Resistance to flow decreases as drying proceeds; drying is considered complete when there is no further decrease of bed resistance (reciprocal of Q/h at a given mean pressure) with time. Preliminary experiments indicated that, once moisture equilibrium had been attained, allowing dry filtered air to pass through the samples for periods up to several days had no effect upon the bed resistance. The weight of the sample under test conditions is taken as the oven-

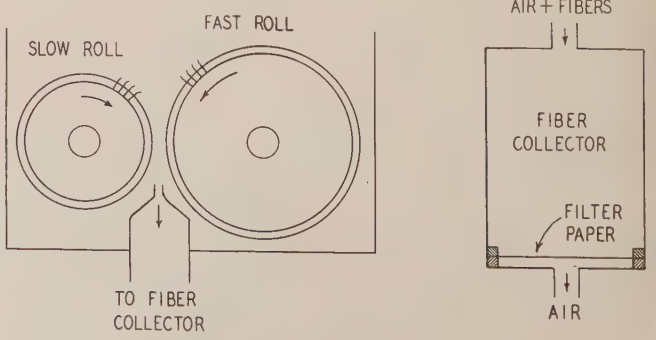

Fig. 3. Defibering device

dry weight. The moisture content at the time of weighing is determined on a separate specimen which is then discarded.

The assembly shown in Fig. 2 is of sufficiently rugged construction that dry wood pulp fiber samples can be compressed in place, by tightening the adjusting nut with a wrench, to porosities as low as 0.6. This corresponds to a pressure of the order of 1000 p.s.i. To compress the fibers to lower porosities, corresponding to those in a sheet of paper, the fiber holder proper is removed from the upper housing and dismantled, care being taken not to disturb the fiber bed. The brass tube, with the fiber bed in its lower end, is bolted to a flat brass plate by means of the lower gasket flange. A steel plunger is lowered onto the bed and the bed is compressed in a hydraulic press under pressures ranging as high as 13,000 p.s.i. The fiber holder is then quickly reassembled (to minimize contact with room air of 50% relative humidity), the movable piston is lowered firmly, and the sample is conditioned overnight to dry air before taking flow measurements.

Batches of dry unbonded fibers were prepared in the following manner. Lightweight handsheets (15 lb., 25 × 40—500) were made in the standard British sheet mold and couched off on blotters. The wet sheets (about 20% oven-dry) were stripped from the blotters and quickly frozen at −25°C. in a vat of petroleum ether. The frozen sheets were then dried by sublimation at −5°C., by passing over them a stream of dry air. In partial substantiation of Campbell's theory (*1*) of sheet formation, Van den Akker (*21*) has demonstrated that, aside from some fiber damage incident to freezing, the lessening of surface tension forces during drying by sublimation from the ice state materially decreases fiber-to-fiber bonding. The sheets dried in this manner in this investigation were of very low density; individual fibers were readily separated from a sheet by small mechanical stresses. When the moisture content was reduced to 7 to 8%, the sheets were defibered, using the simple device shown schematically in Fig. 3. In operation, a strip of the sheet is fed into the nip of the rolls and essentially individually separated fibers are drawn off by suction at the bottom. The tines or prongs (a few of which are shown) on the peripheries of the two rolls are of fine spring steel of the type mounted in a strip of leather or laminated canvas supported by a wood or metal backing and used in machine shops as file cleaners. For the present purpose, the canvas backings were cemented to the steel rolls, and the rolls so spaced that the tines meshed closely. A gear arrangement is used so that the peripheral speed ratio of the rolls is 7.5:1; a hand crank on the shaft of the "fast" roll permits slow operation. Judged by fiber length measurements before and after defibering, fiber damage is scarcely significant. A few "knots" or balls of fibers are formed by the rolling action of the nip; these and any small pieces of undefibered sheet are picked out of the collected fibers before testing. Loss of small fiber elements was not evaluated, but was assumed to be negligible.

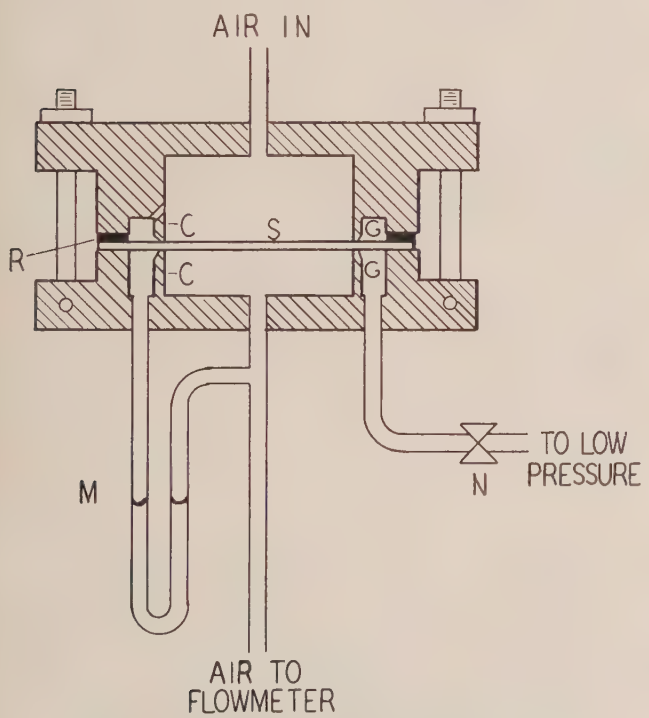

Fig. 4. Sheet sample holder

G Annular guard space
S Sheet sample
C Clamping ring
R Gasket
N Needle valve
M Manometer

Sheet Sample Holder

The sheet sample holder, shown in Fig. 4, was built by Bublitz (*22*) and is based on the annular guard ring principle described by Carson (*23*). The sheet sample S, cut to size, is placed in the holder, and the three swing bolts are tightened firmly with a wrench, to the point that a rather hard sheet is clearly indented, but not cut, by the clamping rings C. Dowel pins assure proper centering. A bead of modeling clay is pressed firmly around the holder at the juncture of the top and bottom halves, to prevent leakage of room air into the guard ring G. A strip of Pliofilm under the clay prevents oil contamination of the sample. In operation, the sample holder is connected with the variable pressure apparatus (Fig. 1) and the sample is conditioned to equilibrium with dry air before flow measurements are taken. A number of small holes drilled through the upper clamping ring near its base assure that air pressure is the same on both sides of the upper clamping ring. The needle valve N (shown in both Figs. 1 and 4 for clarity) is so adjusted that air pressure is equalized on both sides of the lower clamping ring, as indicated by a balance of the menisci of the two legs of the null manometer. Thus, there is no lateral flow through that annular portion of the sheet in contact with the clamping rings. The internal diameter of the clamping rings is 3.000 inches, giving a test area of 45.6 sq. cm. Carson (*24*) has indicated that, in a design of this type, the test area is somewhat larger than this, and used the median diameter of the clamping ring face to establish the test area. However, more severe clamping pressures were used in the present work, so that the clamped area was more highly compressed. In view of the pronounced dependence of permeability on porosity, Carson's empirical correction is not considered applicable to very firmly clamped samples. As the face width of the clamping rings is $^1/_{32}$ inch, the uncertainty should not exceed 2%.

Sheet samples from beaten pulp were handsheets formed in the manner prescribed by TAPPI Standard T 205 m-47, but were pressed and dried between What-

Table II. Permeability Data for Beds of Pulp Fibers

L, cm.	ϵ	b × 10^5, g./(sq. cm. sec.)	c × 10^5, g./(cm. sec.)
Fibers Prepared from Unbeaten Pulp (Sample Weight 6.48 grams)			
4.26	0.9005	5.08	7.0
3.26	0.8698	3.20	5.8
2.76	0.8462	2.28	5.4
2.06	0.794	1.14	3.7
1.66	0.744	0.637	2.52
1.36	0.688	0.330	2.0
1.16	0.635	0.1825	1.33
1.02	0.584	0.103	0.86
0.92	0.538	0.0645	0.70
0.77	0.448	0.0215	0.30
0.67	0.367	0.00823	0.171
Fibers Prepared from Beaten Pulp (Sample Weight 4.68 grams)			
3.10	0.9012	3.73	9.4
2.60	0.8822	2.65	7.9
2.10	0.8542	1.67	6.3
1.95	0.8428	1.38	5.4
1.80	0.8298	1.16	5.0
1.65	0.8142	0.893	4.25
1.50	0.7955	0.683	3.60
1.35	0.773	0.486	3.07
1.20	0.745	0.336	2.35
1.10	0.722	0.246	2.08
0.88	0.652	0.0856	1.03
0.77	0.602	0.0493	0.73
0.69	0.556	0.0264	0.465
0.60	0.511	0.0132	0.29
0.53	0.422	0.00537	0.165
0.49	0.374	0.00369	0.140
0.45	0.318	0.00145	0.0622
0.41	0.252	0.00068	0.0383

man No. 1 filter papers to give a mat surface to both sides of the sheet. Air flow through standard handsheets from unbeaten pulp was decidedly turbulent at measurable rates, and thicker laminated sheets were formed by wet pressing several heavier sheets together prior to drying.

Measurement of Sheet Thickness

The value of the sheet thickness desired for this work was the effective thickness under low degrees of compression, of the order of 1 cm. of mercury or less. The mat surfaces of the sheets were rather irregular, and micrometer methods for measurement of thickness were found to be inadequate. The capacitance method, using mercury for the condenser plates and the sheet sample as the dielectric, is peculiarly suited to the purpose, since the mean thickness thus obtained is the harmonic mean,

Table III. Permeability Data for Handsheets

Sample	L × 10^3, cm.	ϵ	b × 10^5, g./(sq. cm. sec.)	c × 10^5, g./(cm. sec.)
Unbeaten Pulp				
1	40.9	0.574	4.97	47
2	81	0.570	2.55	21
3	31.9	0.445	1.30	19.2
4	61.1	0.435	0.596	9.6
Beaten Pulp				
1	7.08	0.430	0.717	15.8
2	6.98	0.430	0.703	14.3
3	6.84	0.424	0.666	14.4
4	6.82	0.412	0.771	16.7
5	6.77	0.409	0.603	14.3
6	6.74	0.409	0.687	15.2
7	6.76	0.408	0.712	16.4
8	6.73	0.404	0.763	17.1

$$L_{eff} = 1/[(1/n) \sum_{j=1}^{n} (1/L_j)]$$

From D'Arcy's law

$$(u = K \Delta P/\eta L)$$

on which the simple Kozeny equation is based, it is seen that, disregarding any variability from point to point of the permeability constant K, the weighted mean thickness desired for calculations based on flow measurements is also the harmonic mean, rather than the simple average

$$L_{av.} = (1/n) \sum_{j=1}^{n} L_j .$$

Capacitance measurements were taken at a sheet moisture content of 1.8% above the oven-dry state, with a head of 0.8 cm. mercury above the sheet, and thickness was calculated with the aid of the Clausius-Mosotti relationship (*25*). The dielectric constant of dry cellulose was taken (*26*) as 6.1; the effect of the small amount of adsorbed moisture was calculated, from the data of Argue and Maass (*27*), to raise the dielectric constant to about 6.4.

PERMEABILITY DATA

In Table II are listed permeability data for beds of fibers prepared from an unbeaten and a beaten West Coast coniferous bleached sulphite pulp. The pulp was beaten for 30 minutes in a Lampén mill to a freeness of 610 ml. Schopper-Riegler. In Table III are listed permeability data for normally dried handsheets prepared from the same batches of unbeaten and beaten pulp. Porosity was calculated from the relationship

$$\epsilon = 1 - (W/AL\sigma),$$

where σ was taken as 1.55 g. per cc. for sulphite pulp (*28*).

As a possible aid in interpreting the data for pulp fibers, permeability measurements were also made on beds of Corning Pyrex wool filtering fiber, Catalog No. 800.

A number of disks were stamped out of the thin sheets of fibers, slightly larger in diameter than the fiber sample holder, and were laid one on top of the other in the holder in such manner that the fibers were oriented essentially perpendicular to the tube axis. For the second series of measurements, the fibers were cut into 1 cm. lengths and were placed in the fiber holder with no preferred orientation. It is doubtful that the fibers were truly randomly oriented. Because of the danger of fiber breakage, the glass wool fibers were not compressed to porosities below 0.74. Physical data for the fibers are given in Table IV.

TABLE IV. PROPERTIES OF GLASS WOOL FIBERS

	Density
2.55 g./cc.	By displacement of toluene with vacuum removal of air
2.49 g./cc.	By density gradient tube method[a]
	Specific Surface
1710 sq. cm./g.	From microscopic measurements of diameters of 200 fibers[b]
1685 sq. cm./g.	From microscopic measurements of fiber diameters[a]

[a] Measurements made by manufacturer on same carton of fibers.
[b] Measurements made by Wood Technology Dept., The Institute of Paper Chemistry.

Table V. Permeability Data for Glass Wool

L, *cm.*	ϵ	b × 10^5, *g./(sq. cm. sec.)*	c × 10^5, *g./(cm. sec.)*
	Disks		
3.71	0.911	12.0	12.5
2.51	0.869	8.57	13.0
1.91	0.828	6.23	11.5
1.51	0.782	4.35	11.0
1.26	0.738	3.15	9.5
	1-cm. Lengths		
3.50	0.912	15.2	17.5
2.40	0.871	10.4	14.0
1.80	0.828	7.04	13.0
1.40	0.779	4.63	11.5
1.20	0.742	3.50	9.0

As the fiber cross sections were essentially circular, specific surface was calculated from the relationship

$$S = (4/\sigma)\,(\Sigma D/\Sigma D^2)$$

where D is an individual diameter measurement and σ has the value 2.55.

Evaluating constants, when the temperature and the composition of the flowing gas are fixed, and assigning a reasonable value to f, equations (4) and (5) may be written

$$b = C_1\,[\epsilon^3 A/(1-\epsilon)^2 k L S^2 \sigma^2] \qquad (4a)$$

and

$$c = C_2\,[\epsilon^2 A k_0/(1-\epsilon) k L S \sigma]. \qquad (5a)$$

If S is known, k and k_0 may be calculated for beds of varying porosity. If either k or k_0 is assumed independent of porosity and is assigned a reasonable value, values of S and of k_0 or k may be obtained. Values of the ratio L_e/L may be obtained from the relation

$$k = k_0(L_e/L)^2.$$

In Table VI are listed calculated values obtained (when S is assigned a value of 1710) from the permeability data for beds of glass wool given in Table V. It is seen that both k and k_0 decrease somewhat with decreasing porosity. This is the same trend noted by Sullivan (*29, 30*) for beds of rodlike materials having preferred orientations. The ratio of the average length of the path to the thickness of the bed, L_e/L, is seen to be relatively constant and in good agreement with the value, $\sqrt{2}$, assigned by Carman (*3*).

Calculation of Specific Surface

Wood pulp fibers have an irregular poorly defined structure, particularly after beating; the determination of exposed surface area from microscopic measurements

Table VI. Values of Bed Constants Calculated from Permeability Data for Beds of Glass Wool[a]

ϵ	k	k_0	L_e/L
	Disks		
0.911	8.6	3.5	1.57
0.869	7.04	3.29	1.47
0.828	6.40	2.91	1.48
0.782	6.12	2.98	1.43
0.738	5.90	2.78	1.46
	1-cm. Lengths		
0.912	7.3	3.9	1.37
0.871	6.32	2.98	1.46
0.828	6.02	2.91	1.44
0.779	5.95	2.87	1.44
0.742	5.85	2.43	1.55

[a] Using S = 1710 sq. cm./g., obtained from microscopic measurements.

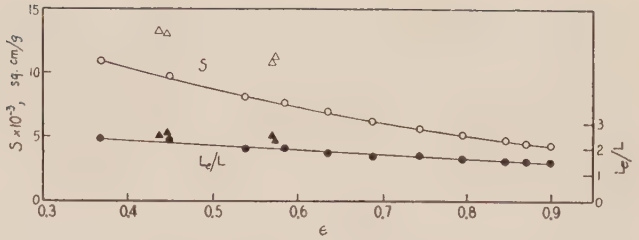

Fig. 5. Dependence of calculated values of S and Le/L on porosity assuming k = 6, for the unbeaten pulp

S: ○ Fibers, △ Handsheets — *Le/L*: ● Fibers, ▲ Handsheets

is too uncertain to be of much use in evaluating k_0 and k from permeability data. In order to determine the percentage of bonded area in sheets of paper, it seems more profitable to assign reasonable values to k_0 or k and calculate relative values of exposed surface area of beds of fibers and of the corresponding handsheets. In view of the dependence of calculated values of specific surface on porosity, the comparison should be made at the same porosity. For beds of rodlike materials at high porosities, as shown in Table VI, values of 3 and 6 appear reasonable for k_0 and k, respectively. Carman (*3*) has shown that, for single channels having rather elongated cross sections (the probable shape of the "average" pore in beds of fibers), the shape factor varies between 2.5 and 3. Calculations (*12*) based on the data of Lea and Nurse (*9*) show that values of k_0 lying between 2.5 and 3 are appropriate for granular beds. Values of k ranging from 5 to 6 have been found applicable to rather highly porous beds of various rodlike particles having no preferred orientation, or oriented with their axes perpendicular to the bed axis (*20, 31, 32*). Values of exposed specific surface calculated from the permeability data for handsheets and for beds of fibers will be compared, assigning values of 6 to k and 3 to k_0, in turn.

In Figs. 5 and 6, calculated values of S (using $k=6$) are shown for the unbeaten pulp and the beaten pulp, respectively. It is noted that the exposed specific surface of the handsheets is significantly greater than for the beds of fibers at corresponding porosities. As this is

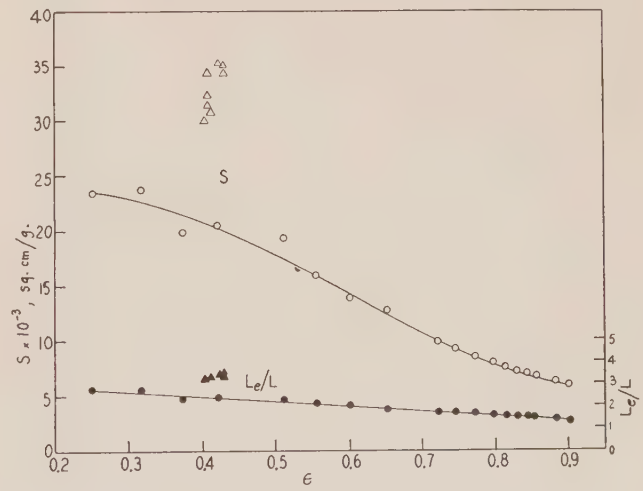

Fig. 6. Dependence of calculated values of S and Le/L on porosity, assuming k = 6, for the beaten pulp

S: ○ Fibers, △ Handsheets — *Le/L*: ● Fibers, ▲ Handsheets

entirely unreasonable, this method of approach can be ruled out. It is of interest that, when k is assumed constant, there is a large and consistent increase in calculated values of S with decreasing porosity, in contrast to the trend for the beds of glass wool fibers, but in substantial agreement with results reported for irregularly shaped particles (*9*, *16*, *17*). Application of the porosity correction suggested by Keyes (*19*) is unsatisfactory, as a curved plot is obtained at the lower porosities, the range of greatest interest. Plots of

$$S\sigma(1 - \epsilon) \text{ vs. } \epsilon,$$

an empirical method proposed by the American Society for Testing Materials (*17*) for obtaining values of specific surface which are independent of porosity, approach linearity at the lower porosities and yield values, using the "B" point, of about 14,000 and 26,000 sq. cm. per gram for beds of the unbeaten and beaten fibers, respectively. However, this method cannot be applied to the data for the handsheets.

The calculated values of S, using $k_0 = 3$, are shown for the unbeaten and beaten pulps in Figs. 7 and 8, respectively. Values of S for the beds of fibers are essentially independent of porosity over the range $0.37 < \epsilon < 0.9$. For this range, average values are 3800 sq. cm. per gram for the unbeaten fibers and 6750 sq. cm. per gram for the fibers beaten to a Schopper-Riegler freeness of 610 ml. It is seen that, for the unbeaten pulp, the exposed specific surface of the handsheets is, within experimental uncertainty, the same as for the beds of fibers. The area used for fiber-to-fiber bonding may be assumed to be quite small. In the case of the beaten pulp, the exposed specific surface of the handsheets is only 70 to 75% of that of the beds of fibers. The difference is assumed to be the area in very close fiber-to-fiber contact in the handsheets, and may be taken as a measure of the area utilized for fiber-to-fiber bonding. The decrease in values of S for beds of fibers at porosities below 0.37, as shown in Fig. 8, may be significant. Possibly, the value of the pore shape factor is changing; a reasonable explanation, however, is that the area of close contact between contiguous fibers is becoming appreciable.

Few data are available for the specific surface of pulp fibers. Because of different methods of pulp preparation, comparisons are of questionable value. Graff, Schlosser, and Nihlen (*33*) have published drawings of unbeaten fiber cross sections and average values of pertinent dimensions, from which relative values of specific surface may be obtained. Using the relation $S\sigma =$ (perimeter of cross section)/(net area of cross section), and calculating from their data for pulps 10A and 10B, a value of 2840 sq. cm. per gram is obtained for the microscopically visible external surface. This figure undoubtedly is low because of the method of averaging. Using the catalytic method, which involves the deposition of a thin layer of silver on the fibers in water suspension, Clark (*34*) reported a value of 8800 sq. cm. per gram for a similar unbeaten pulp, and 11,000 to 12,000 sq. cm. per gram for the same pulp when moderately beaten. The application of a modified catalytic silvering method to the pulp studied in this investigation gave values of 9300 sq. cm. per gram for the unbeaten fibers and 10,200 sq. cm. per gram for the beaten fibers.*

* These values were furnished by the Analytical Department of The Institute of Paper Chemistry.

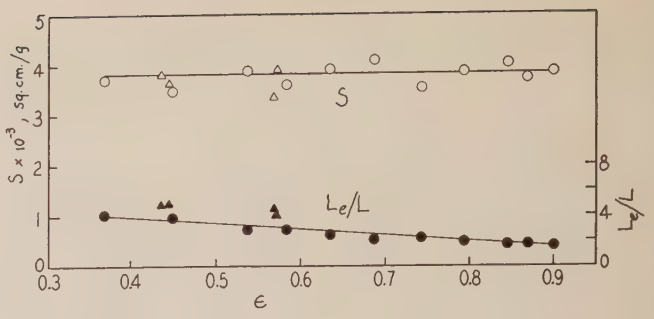

Fig. 7. Dependence of calculated values of S and Le/L on porosity, assuming k₀ = 3, for the unbeaten pulp

S	Le/L
○ Fibers	● Fibers
△ Handsheets	▲ Handsheets

Using the simple Kozeny equation for calculating water-permeability data for high porosity beds of sulphite pulp fibers, and assuming $k = 5$, Mason (*35*) reported a value of 16,200 sq. cm. per gram for the unbeaten pulp, which increased substantially with beating.

For the fiber beds, when k_0 is 3, the ratio L_e/L increases consistently from values slightly greater than unity at a porosity of 0.9 to values of about 4 at a porosity of 0.37. Pulp fibers are readily deformable under compression; it is reasonable that, as the fibers are flattened into ribbonlike particles and are brought more closely together, the permeating fluid is forced to follow a more tortuous path through the bed. The ratio L_e/L is significantly higher for the handsheets than for the fiber beds at the same porosity. This possibly may be explained in terms of the "surface orientation factor" proposed by Fowler and Hertel (*20*) and Sullivan and Hertel (*32*). These authors substituted an expression $1/(\sin^2\varphi)_{av.}$ for $(L_e/L)^2$. The term $(\sin^2\varphi)_{av.}$ is the mean value of the square of the sine of the angle φ, this angle being taken as that between the axis of flow—i.e., the axis of the bed—and the normal to an element of surface exposed to flow. For idealized beds of particles having preferred orientations, theoretical values of the surface orientation factor and, hence, of $(L_e/L)^2$ may be obtained. The orientation of the particles in the beds of fibers is not known; however, it is likely

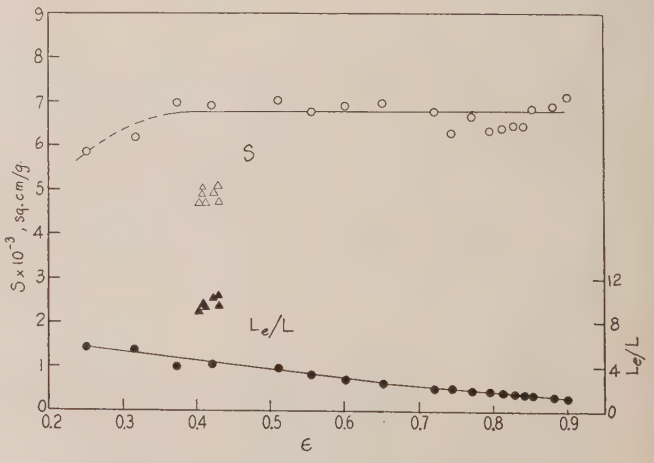

Fig. 8. Dependence of calculated values of S and Le/L on porosity, assuming k₀ = 3, for the beaten pulp

S	Le/L
○ Fibers	● Fibers
△ Handsheets	▲ Handsheets

that some of the fibers are oriented with their axes in a direction more or less parallel to the axis of flow. In the handsheets, the fibers lie with their axes essentially parallel to the plane of the sheet and, hence, normal to the axis of flow. Thus, qualitatively at least, the permeating fluid would be expected to follow a more tortuous course through the handsheets than through the beds of fibers. This very likely explains the anomalous values for specific surface obtained for the handsheets in comparison with beds of fibers at the same porosity, when k is assumed constant for the two cases; k is apparently larger for the handsheets.

The effective specific volume (reciprocal of effective fiber density) occupied by the fibers in a bed has been discussed by Fowler and Hertel (*20*) and by Campbell (*36*). Flow data may be used to estimate effective fiber density by adapting the method of Fowler and Hertel. Let L_0 = thickness of bed when the porosity is zero—that is, when the bed has been compressed to the extent that all the air is excluded, and it consists only of solid fiber. At any thickness of bed greater than L_0, the solid fraction is given by L_0/L and the void fraction, or porosity, by $1-(L_0/L)$. Making these substitutions for the porosity terms in equations (4a) and (5a) and eliminating k by solving simultaneously,

$$cL/b = cL_0/b + (C_2/C_1)L_0k_0S\sigma \qquad (6)$$

For a bed of fibers compressed by stepwise lowering of a movable piston, a plot of the experimentally determined quantities,

$$cL/b \text{ vs. } c/b$$

should be linear if k_0 and σ are constant, the slope giving an estimate of L_0. Such plots of the data given in Table II are shown in Fig. 9. Calculating the density of the solid material from the slopes of the lines by use of the relationship

$$\sigma = W/AL_0$$

values of 1.65 and 1.49 grams per cc. are obtained for the density of the unbeaten and beaten fibers, respectively; these are in fair agreement with values obtained by displacement means. Hence, it may be assumed either that the individual fibers are flattened out under compression, so that there is little internal void space, or that air flows through the fiber lumens, as suggested by Carson (*24*). Thus, the use of density values obtained by displacement means is permissible for calculating specific surface, for moderate degrees of compaction.

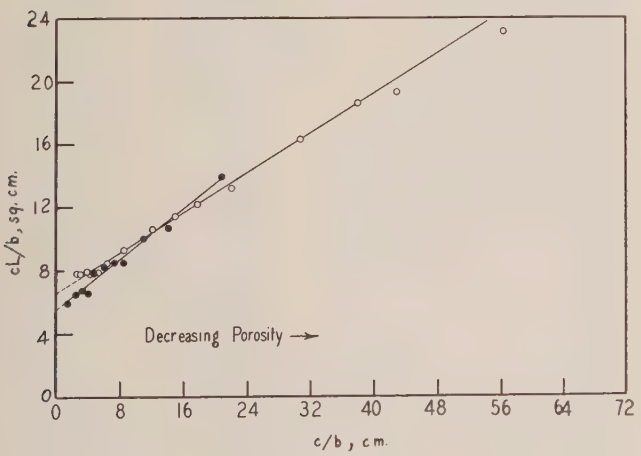

Fig. 9

A plot of the experimental data given in Table I for varying compaction of the beds of fibers. No assumption is made as to the effective density of the fibers. The slopes of the lines give estimates of L_0, the hypothetical thickness of the bed when compressed to such an extent that it consists only of solid fiber substance. From the weight and cross-sectional area, and the value of L_0, an estimate can be made of the effective fiber density under test conditions.

● Bed of unbeaten fibers
○ Bed of beaten fibers

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Corrosion and Corrosion Testing in the Pulp and Paper Industry

R. A. HUSEBY and M. A. SCHEIL

General corrosion, pitting, intergranular attack, stress corrosion cracking, galvanic corrosion, dezincification, and erosion corrosion are discussed with examples from the pulp and paper industry. Appropriate remedial measures such as alloy selection and heat treatment are included. The pronounced effect of carbon content on pitting tendency in both laboratory and field tests is illustrated. It is shown that increased corrosion resistance in the ammonium bisulphite process can be effected by keeping chrome content of type 316 analyses on the high side of the range. Metallurgical considerations in fabrication of alloy-lined equipment are discussed.

Corrosion has been defined by Evans (*1*) as destruction by chemical or electrochemical agencies in contrast to erosion which denotes destruction by mechanical means. Actually some of the most rapid metal failures are caused by a combination of the two actions.

Environmental factors such as temperature, pH value, velocity, film formation, as well as the presence of oxidizing agents and inhibitors, determine the corrosion rate of a material in any process. Figure 1 illustrates the effect of temperature on a 12% chrome alloy. Entirely satisfactory at 212°F. raising the temperature of the water to 235°F. resulted in severe pitting and intergranular attack.

Factors peculiar to the alloy itself include surface condition, stress (both residual and applied), and heat treatment. As a matter of fact a metal crystal corrodes at different rates depending upon the crystallographic face presented to the corrosive media. While this is chiefly a matter of academic interest, etching of annealed alloys for metallographic examination is effective largely because of differential rates of attack on differently oriented crystals. Figure 2 shows a homogeneous single crystal of a stainless alloy in which the twinned portion, which has a slightly different crystallographic orientation from the remainder of the crystal, has corroded preferentially.

CLASSIFICATION OF CORROSION TYPES

A more or less arbitrary classification of corrosion types can be made which is very helpful in diagnosing such failures, keeping in mind the fact that all types are interrelated, often occur in combination, and are manifestations of the same phenomena. All corrosion reactions involve an anodic (oxidizing) and cathodic (reducing) portion which occur simultaneously with an electron flow between the two areas.

General or Uniform Attack

While this type of corrosion may account for the greatest loss on a tonnage basis, it is not the most dangerous form. Changes in temperature, pH value, removal of inhibitors and removal or addition of oxidizing agents may result in sudden accelerated general attack which can cause rapid failure. Figure 8 showing a section of type 304 alloy previously in use as a blow pit floor illustrates severe uniform attack.

Pitting

This is one of the most destructive types of corrosion and usually occurs in stainless steel as a result of local breakdown of passivity. Table I shows the high potential which exists between active and passive 18–8. When passivity is destroyed at some discrete point on the surface the resulting current flow starts corrosion at the active area. The chloride ion, with other members of the halogen group, is especially active in initiating pitting of stainless steels.

Pitting is easily recognized. Figure 3 shows the typical surface appearance of a badly pitted section of type 430 (16–18% chrome) exposed 2 weeks in hot-softened water at 235°F. Figure 4 is a transverse section through the same alloy illustrating the typical small hole greatly enlarged beneath the surface. In this par-

Table I. Galvanic Series of Metals and Alloys

Electromotive series *Metal*	*Volts*	*Practical series; material or alloy*
Corroded end (anodic or least noble)		
Mg^{++}	−1.55	Magnesium
		Zinc
Al^{+++}	−1.33	Aluminum 2 S
		Cadmium
Zn^{++}	−0.76	Steel or iron
		Cast iron
Cr^{++}	−0.56	13% Cr iron (active)
		Ni-resist
Fe^{++}	−0.44	18–8 S (active)
		18–8 S Mo (active)
Cd^{++}	−0.40	Chlorimet 3
		Hastelloy C
Co^{++}	−0.29	Lead
Ni^{++}	−0.23	Nickel (active)
		Inconel (active)
		Hastelloy A
Sn^{++}	−0.14	Chlorimet 2
		Hastelloy B
		Brasses
Pb^{++}	−0.12	Copper
H^{+}	0.00	Bronzes
Sb^{+++}	+0.1	Copper-nickel alloys
		Monel
Cu^{++}	+0.34	Nickel (passive)
		Inconel (passive)
		Chromium iron (passive)
Ag^{++}	+0.8	18–8 S (passive)
		18–8 S Mo (passive)
Au^{+++}	+1.36	Silver
		Gold
		Platinum
Protected end (cathodic or most noble)		

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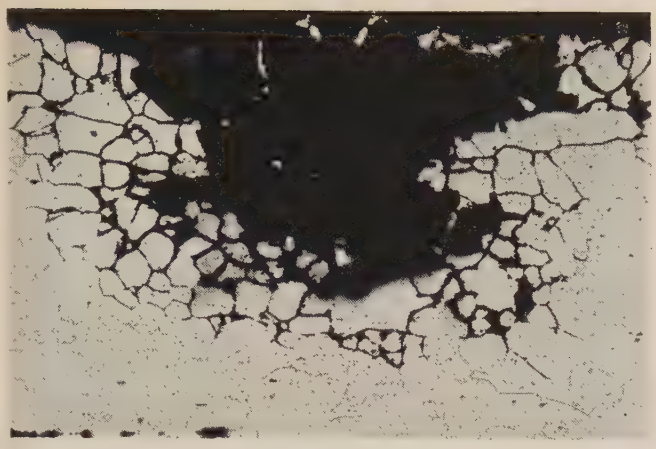

Fig. 1. Pitting and intergranular corrosion of type 405 (12% chrome) alloy exposed in hot-softened running water at 235°F. At temperatures of 212°F. or below the alloy is satisfactory

ticular exposure 12% chrome pitted severely, type 430 (16–18% chrome) showed considerable pitting, type 446 (27% chrome), Inconel and 18–8 showed no pitting.

It has not been generally recognized that precipitation of carbide or sigma phase by heat treatment can cause or accelerate pitting. In Fig. 5 the result of heat treatments which develop a carbide phase in an 18–8 alloy is shown with its effect upon pitting tendency in a 10% $FeCl_3$ solution. The effect of alloy content in reducing pitting in the same solution is shown in Fig. 6 and 6A. Figure 7 shows the pronounced effect of carbon on pitting in a series of 18–8 Mo alloys. The extra low carbon (0.03% C max.) is shown to have considerable advantage over the 0.08% C max. variety. These illustrations all serve to point out the fact that any heat treatment which develops nonhomogeneity sets up a condition favorable to pitting.

Fig. 2. Single crystal of stainless alloy showing effect of crystallographic orientation on corrosion rate

The dark band represents a twinned portion with slightly different orientation which corroded out leaving the remainder of the crystal.

Figure 8, a transverse section through a type 304 alloy from a blow pit floor used in calcium bisulphite service, shows combined pitting and transgranular cracking. Concentration of chemicals in the pits was probably responsible for the cracking which followed. Type 316, which would be resistant to pitting, would be preferred for this service.

Pitting can also be caused by conditions favoring stagnant areas or crevices where the corrosion reaction can be initiated because of difference in solution concentration. Figure 9 shows a section of type 316 heat exchanger tube severely pitted on the water side. Failure was caused by dirty cooling water containing particles of organic matter which settled on the tubes. The shielded areas under the loosely adhering material became low in oxygen setting up an oxygen concentration cell in which these areas are anodic and corrode. This effect is further accelerated by the breakdown of the passive film at the anode which adds to the original potential produced and further increases the pitting rate. Clean cooling water or periodic cleaning of the tubes would remedy this condition.

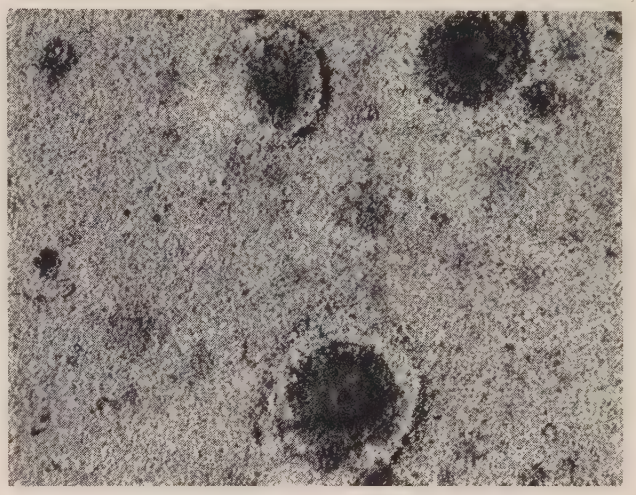

Fig. 3. Surface appearance of type 430 alloy which showed considerable pitting after two weeks' exposure in hot-softened water at 235°F.

Pitting or "bright spot" corrosion of a carbon steel sulphate digester is shown in Figs. 10 and 11. In this case the protective film formed on the carbon steel surface has broken down locally and the potential difference existing between the film coated area (cathodic) and the bright areas (anodic) causes corrosion of these areas. X-ray diffraction patterns on scale collected from sulphate mill digesters located in the southern, north western, and north central regions show this film to be predominantly $CaCO_3$ as calcite.

Intergranular Attack

Under certain conditions preferential grain boundary attack of a metal can occur. Much has been written and published in the last 15 years on intergranular corrosion of stainless steels. Actually carbon steels and nonferrous alloys are equally if not more susceptible to intergranular attack than the stainless steels. The severe conditions under which stainless is usually used plus the intriguing nature of the phenomena in 18–8 varieties has focused a great deal of attention on this

form of corrosion. The explanation for intergranular corrosion of austenitic stainless steels was first suggested by Aborn and Bain in a brilliant paper on nickel-chromium stainless steels in 1930 (*2*). Briefly the explanation is this: Properly annealed 18–8 is a single phase solid solution of chromium, nickel, carbon, iron, and other residual elements in austenite. If this alloy is cooled fairly rapidly to room temperature, it remains a single phase solid solution in spite of the fact that the carbide solubility decreases rapidly with decreasing temperature. If for any reason this annealed alloy should be heated to an intermediate temperature such as 1100 to 1200°F., a common stress-relieving temperature in fabrication, part of the carbon soluble at the higher annealing temperature but insoluble at the lower temperature will tend to precipitate out as chromium carbide because of the strong affinity of chromium for carbon. This separation will first occur at the grain boundaries because of the greater atomic mobility at these surfaces. The resulting depletion of chromium at the grain boundaries creates a zone of nonstainless metal around each grain which can corrode preferentially.

Fig. 4. Transverse section through one of the pits shown in Fig. 3

In the fabrication of stainless steel heating in the 900 to 1400°F. danger zone can occur during stress relieving or in welding where a zone adjacent to the deposited metal is heated to an intermediate temperature. There are three methods of eliminating the trouble: (1) Annealing of the fabricated article by rapid cooling from the carbide solution temperature (about 1900 to 2000°F.). This can be done where size and shape permit. (2) Using strong carbide formers such as columbium and titanium which form a much more stable and insoluble carbide than chromium. (3) Using extra low carbon materials. Here the carbon content is so low that precipitation cannot occur during normal welding or stress-relieving operations. So far this has been the most satisfactory solution when type 316 is required. Although a type 316 Cb analysis has been produced, it is extremely difficult to incorporate 2 to 3% Mo with about 1% Cb and obtain a consistently satisfactory alloy. (4) A fourth method is often used with castings. Here the analysis is so adjusted that a mixed structure of austenite and ferrite exists at room temperature. On heating in the sensitizing range carbide precipitation occurs largely in the ferrite

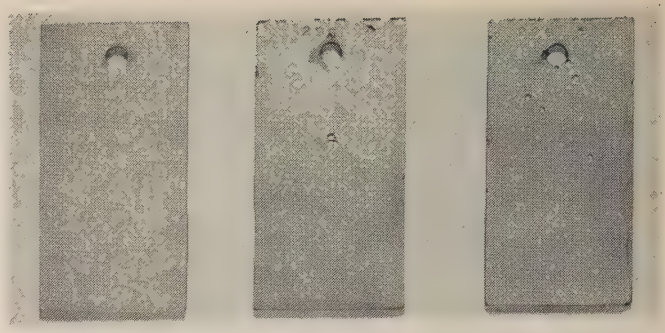

Fig. 5. Effect of heat treatment on pitting tendency

No pits Anneal + 1950°F. air cool 0.004 g. wgt. loss	Pitted Anneal + 1600°F. 1 hr. 1.668 g. wgt. loss		Pitted Anneal + 1200°F. 2 hr. 2.128 g. wgt. loss
	Chemical Analysis, %		
C	Cr	Ni	Mo
0.06	18.64	12.95	2.44

pools where it is relatively harmless since no continuous network is formed. Also chromium probably diffuses more rapidly in ferrite and less local depletion occurs. If no carbides are present the mixed structure, austenite plus ferrite, has no adverse effect on pitting tendency. The usual method of obtaining this structure is to lower the nickel content to around 9 or 10% in a 316 analysis. This lower nickel content has been advocated in the paper industry and it is quite probable it has found favor because of its greater resistance to intergranular corrosion.

As was previously stated, stainless steel is by no means the only alloy subject to intergranular corrosion. Figure 12 shows an aluminum bronze which developed very severe intergranular corrosion after exposure to steam at 600°F. Figure 13 shows intergranular attack of pure nickel exposed in a strong caustic solution in the treating of waste sulphite liquor.

Unless temperature of operation exceeds 900°F. intergranular corrosion of the austenitic 18–8 varieties of stainless steel is under control of the steel mill and fabricator and close metallurgical control will minimize the possibility of its appearance.

Stress Corrosion

In some instances metal failure occurs suddenly in a brittle manner with stresses below the yield point. Careful examination reveals that the metal itself has undergone no metallurgical change to account for the cracking. Hardness and ductility adjacent the cracks

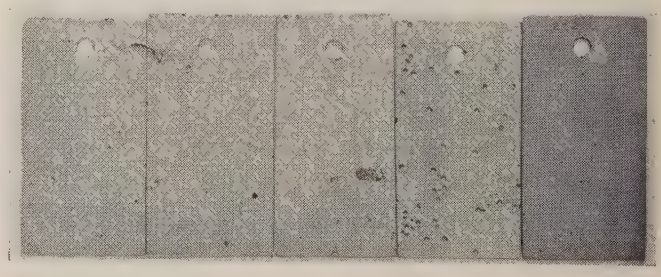

Fig. 6. Effect of alloy content on pitting tendency

Pitted 1950°F. Type 302	Pitted 1950°F.	Pitted 2350°F. W. Q. 304	Pitted 1950°F.	No pits 2350°F. W. Q. 310
Analysis, %				
C 0.09		0.06		0.13
Cr 17.46		18.50		25.26
Ni 6.94		9.45		20.73

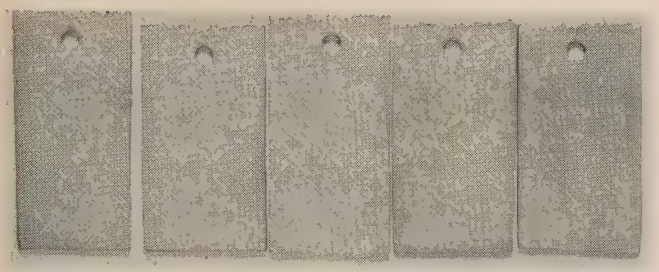

Fig. 6A. Effect of molybdenum content on pitting tendency

	2 Small Pits	Pitted	No pits	No pits	No pits
Wgt. Loss	0.158 g.	0.381 g.	0.004 g.	0.006 g.	0.001 g.
Mo. %	2.00	2.02	2.44	2.90	3.68

Heat treatment 1950°F. air cool anneal
18% chrome 12% nickel

remains unchanged. Season cracking of cartridge brass in atmospheres containing traces of ammonia and caustic embrittlement of carbon steel used in steam boilers were among the first recognized instances of stress corrosion. Two conditions must be fulfilled before stress corrosion can occur: (1) stress must be present either as residual stresses from fabrication as in rolling or welding or as applied stresses from pressure or thermal gradients and (2) corrosive environment must be right.

Generally residual stresses are much more damaging than design stresses.

Cracking media varies widely between different materials. Elevated temperature is sometimes required although this is not always necessary as brasses and stainless steels can be cracked at room temperature.

Stainless steels of the 18–8 and modified 18–8 types are subject to stress corrosion in strong chloride solutions and strong caustic solutions at high temperatures.

Figure 14 shows a section through a type 347 boiling coil which carried an organic acid with sodium chloride. Typical transgranular stress corrosion cracks can be observed. Residual stresses were high (hardness 192 Vickers as compared to about 130 Vickers for a properly annealed alloy). The replacement coil was annealed and gave satisfactory service.

Figure 15 shows a $^1/_4$ inch thick by $5^3/_4$ inch O.D.

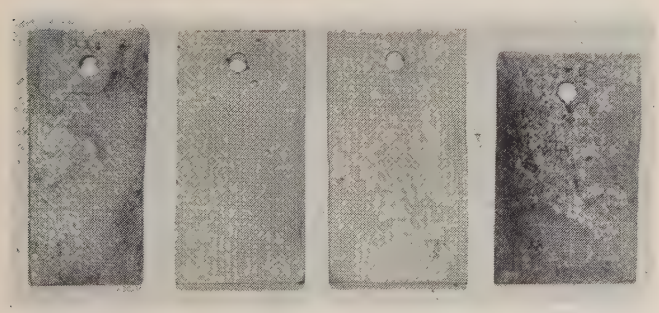

Fig. 7. Effect of carbon content on pitting tendency

	Pitted and sugared	Pitted	2 Small pits	Pitted and sugared
Wgt. Loss	16.080 g.	2.128 g.	0.094 g.	16.770 g.
C, %	0.07	0.06	0.02	0.08
Mo, %	2.65	2.44	2.50	3.17

Heat treatment 1950°F. anneal + 1200°F. 2 hr.
18% chrome 12% nickel

type 304 liner for an inlet nozzle to a liquor heating tank handling hot sulphate liquor at about 300°F. Cracking pattern adjacent the weld indicates no or ineffective stress relief. The replacement nozzle was annealed at 1950°F. and has given satisfactory service. The vicious character of this type of corrosion is shown in Fig. 16 where a $1^1/_2$-inch wall type 347 autoclave cracked and leaked after 90 hours' service handling 70% caustic with organic salts at about 525°F.

A typical type 304 vibrating screen plate from an installation in which failure by cracking occurred in as little as 2 to 3 days is shown in Fig. 17. This unit was used to screen and classify sulphite pulp. Residual stresses were high due to cold forming and machining. Hardness varied from 121 Vickers in areas not deformed in fabrication to 257 Vickers at the edges where cracking was most pronounced. After annealing at 1950°F. a 10-plate section gave satisfactory service for five months when it was replaced for other reasons.

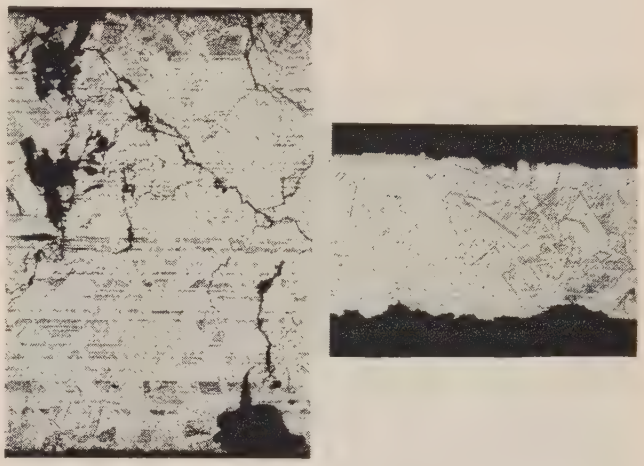

Fig. 8. Transverse sections through two type 304 alloys—one from calcium and one from ammonium base sulphite service

Section on the left is from calcium base service and shows severe pitting and stress corrosion cracking but little general attack. The section on the right, from ammonium base service, shows only severe general corrosion. Both were originally the same thickness. Type 316 would be preferred for this service. In the ammonium base process chromium should be kept on the high side of the range.

Transgranular cracks are typical of stress corrosion failures in austenitic 18–8 varieties. Carbon steels and nonferrous alloys usually exhibit an intergranular type of failure although when stresses are high cracking becomes transgranular. If stress removal eliminates the cracking, the failure is due to stress corrosion. If the stress-free alloy corrodes intergranularly, it is a type of failure previously discussed under Intergranular Attack.

Galvanic Corrosion

When two dissimilar metals are in contact or electrically connected in an electrolyte the potential setup can cause severe corrosion of the anodic—least noble—metal.

The galvanic series shown in Table I is useful in predicting such behavior. Although this tabulation was compiled from sea water tests, largely conducted by the International Nickel Co., it is of considerable value in predicting galvanic corrosion in other media. Pas-

sivity and film formation may, however, change the relative positions of the various alloys.

Obviously coupling metals widely apart on the series is inviting trouble. Small areas of anodic metal in contact with large areas of more noble metal is dangerous since a large current can be concentrated over a small area and rapid failure can occur. For the same reason coatings applied to the anodic metal can be dangerous since in any imperfection of the coating a very accelerated attack can occur. In some cases it is actually more desirable to coat the noble metal in order to cut down the current flow and dissipate it over a wide area.

An interesting application of galvanic corrosion is cathodic protection. There are two methods in use: (1) electrically connecting a less noble metal to the metal to be protected, and (2) impressing a potential and supplying a current counter to that setup at the anode by the corrosive reaction.

In the first method sacrificial anodes of magnesium, aluminum, or zinc, metals high on the galvanic series, are commonly used. In the second method an external

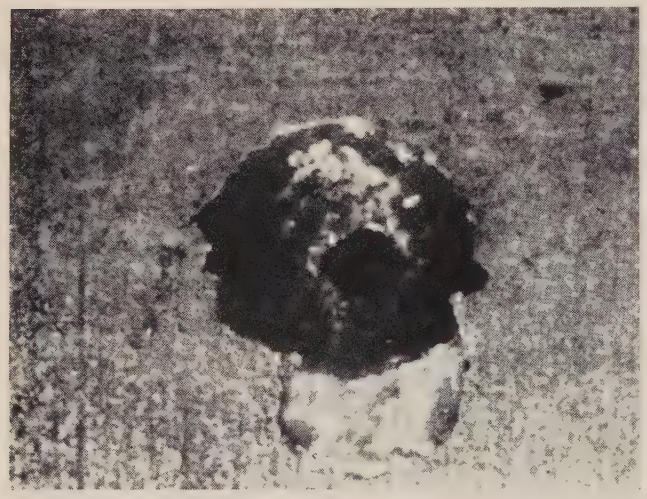

Fig. 9. Pitting of type 316 heat-exchanger tube on water side caused by dirty cooling water

source of direct current is so applied that the local currents causing corrosion are neutralized or reversed. Anodes here may be an inert material such as carbon. In chemical process equipment the method is difficult to apply because of complexity of shape. Where high corrosion rates are involved the method is generally not applicable. When sacrificial anodes are used, the process must be such that they remain active. Once coated with scale or film, protection is lost.

Dezincification

Under certain conditions copper alloys may exhibit a type of corrosion which involves leaching out of the principle alloying element and deposition of copper. It is readily recognized since areas of red copper are plainly visible in contrast to the lighter colored brass or bronze. Figure 12 showing intergranular corrosion of aluminum bronze is also an example of this type of attack although here the element leached out is aluminum and would therefore really represent dealuminumification. Close examination will reveal a dark zone around the exposed grains which represents the deposited copper. Arsenic, antimony, and phosphorus in very small

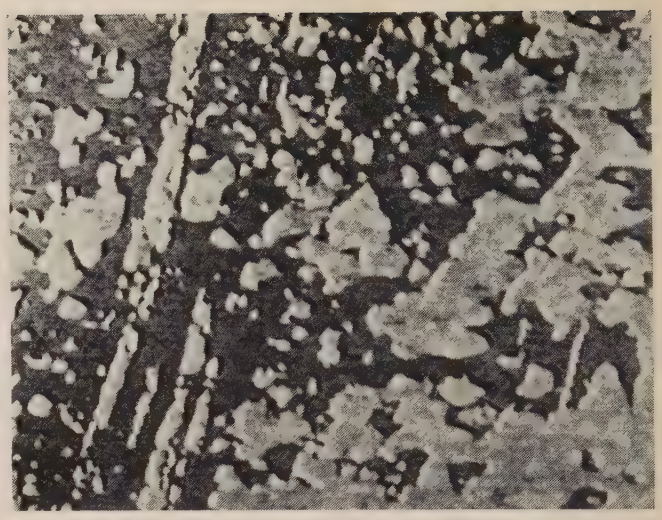

Fig. 10. "Bright spot" corrosion in carbon steel sulphate digester

amounts are commonly added to brasses to inhibit dezincification. Protection is credited to insoluble films of these compounds. The high brasses such as cartridge brass and Muntz metal are more susceptible to both dezincification and season cracking than are the brasses containing small percentages of zinc.

Erosion Corrosion

Several types of attack can be included in this classification. All involve gases or liquid under high velocity. Cavitation and impingement are two examples. When a certain critical velocity is exceeded, films which ordinarily protect the alloy are removed as fast as they form and corrosion goes on continuously. In some instances high velocity causes vapor bubbles to form and collapse suddenly. The resulting rapid corrosion, which in effect hammers the alloy away, is called cavitation. Any gas or liquid which contains abrasive material in suspension will, of course, result in very rapid wear.

Figure 18 showing a section of a type 316 lined SO_2 cooler illustrates the result of direct impingement of hot gases with entrained sulphuric and sulphurous acid. Corrosion here was concentrated in this one area which was remedied by installing a new lined plate and a wooden baffle to stop direct impingement.

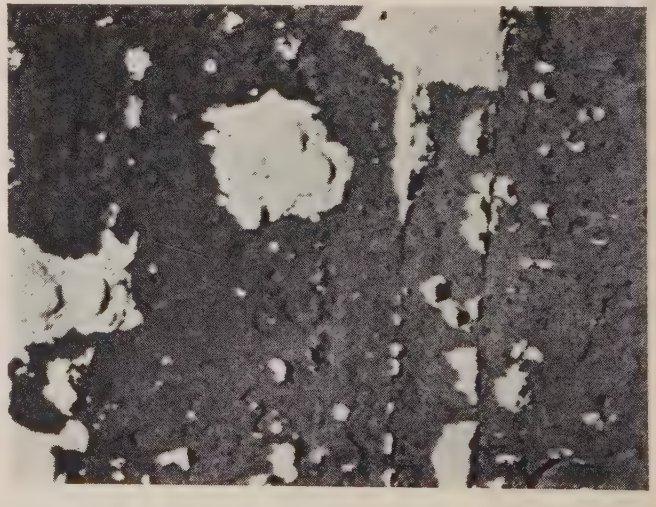

Fig. 11. "Bright spot" corrosion in carbon steel sulphate digester showing some preferential attack at the weld

Table II. Calcium Bisulphite Process (10% SO_2)

Alloy	Heat	Weld	Specimen	Heat treatment	Corrosion rates (IPY) 6 mo.	12 mo.	18 mo.	24 mol	Av.
(L. C.) 0.03% C max. type 316	1X5548	AISI 310 Mo	Crossweld	Stabilized 1650°F.	0.0005	0.00030	0.00022	0.00019	0.00034
(L. C.) 0.03% C max. type 316	1X5549	AISI 310 Mo	Crossweld	Stabilized 1650°F.	0.0006	0.00037	0.00032	0.00023	0.00043
(L. C.) 0.03% C max. type 316	2X4981	AISI 310 Mo	Crossweld	Stabilized 1650°F.	0.0005	0.00031	0.00025	0.00021	0.00035
(L. C.) 0.03% C max. type 316	2X4982	AISI 310 Mo	Crossweld	Stabilized 1650°F.	0.0005	0.0004	0.00026	0.00024	0.00039
(L. C.) 0.03% C max. type 316	2X4983	AISI 310 Mo	Crossweld	Stabilized 1650°F.	0.0005	0.00042	0.00023	0.00022	0.00038
(L. C.) 0.03% C max. type 316	1X5548	AISI 310 Mo	Crossweld	Stress relieved 1000°F.	0.0003	0.00022	0.00017	...	0.00023
(L. C.) 0.03% C max. type 316	1X5549	AISI 310 Mo	Crossweld	Stress relieved 1000°F.	0.0003	0.00027	0.00018	0.00016	0.00025
(L. C.) 0.03% C max. type 316	2X4981	AISI 310 Mo	Crossweld	Stress relieved 1000°F.	0.0003	0.00022	0.00018	0.00015	0.00023
(L. C.) 0.03% C max. type 316	2X4982	AISI 310 Mo	Crossweld	Stress relieved 1000°F.	..	0.00025	0.00020	0.00016	0.00023

Laboratory HNO_3 tests[a]

Alloy	Heat	Weld	Heat treatment	Corrosion rates (IPY)					Av.
L. C. type 316	1X5548	310 + Mo	Stabilized at 1650°F.	0.009	0.012	0.014	0.019	0.024	0.018
L. C. type 316	1X5548	310 + Mo	Stress relieved at 1000°F.	0.009	0.011	0.019	0.026	0.039	0.021
L. C. type 316	1X5549	310 + Mo	Stabilized at 1650°F.	0.008	0.011	0.014	0.017	0.023	0.015
L. C. type 316	1X5549	310 + Mo	Stress relieved at 1000°F.	0.009	0.009	0.013	0.019	0.021	0.014
L. C. type 316	2X4981	310 + Mo	Stabilized at 1650°C.	0.012	0.017	0.027	0.036	0.045	0.017
L. C. type 316	2X4981	310 + Mo	Stress relieved at 1000°F.	0.010	0.011	0.015	0.018	0.022	0.015
L. C. type 316	2X4982	310 + Mo	Stabilized at 1650°F.	0.012	0.014	0.021	0.030	0.034	0.022
L. C. type 316	2X4982	310 + Mo	Stress relieved at 1000°F.	0.012	0.015	0.020	0.025	0.028	0.020
L. C. type 316	2X4983	310 + Mo	Stabilized at 1650°F.	0.013	0.016	0.019	0.027	0.038	0.018
L. C. type 316	2X4983	310 + Mo	Stress relieved at 1000°F.	0.009	0.010	0.014	0.018	0.024	0.015

[a] Five 48-hour periods in boiling 65% nitric acid.

Figure 19 shows a section through a welded carbon-steel tee joint handling hot sulphate liquor. Here poor fit up resulting in lack of fusion at the root of the weld caused turbulence and severe corrosion at the joint. Design is one of the biggest factors in cases of erosion-corrosion. Channeling of steam in digesters during cooking probably causes some of the corrosion which could be minimized by better design of steam inlet nozzles.

FIELD CORROSION TESTING

In the previous section a broad classification of corrosion based on the response of the metal to the corrosive media has been made. If the exact degree to which each of these reactions is met with were known, field corrosion testing would not be necessary. However practical consideration of the variables involved points to field testing as the easiest and safest method of determining two very important facts: (1) choice of alloy for new or replacement equipment, and (2) effect of changes in process on existing equipment.

The first point is determined by exposing a suitable series of specimens which include normal fabrication treatments of welding and heat treatment. The second question, of considerable importance to any plant with a large investment in alloy equipment, is answered by continuously exposing and regularly examining specimens of the same type as that used in existing equipment. Table II gives a correlation between field tests in a sulphite digester and laboratory HNO_3 tests on specimens with identical treatments. The curve shown in Fig. 20 shows a pronounced lowering and leveling off of corrosion rates as determined by specimens removed at regular intervals.

Figures 21 and 21A illustrate the effect of carbon, heat treatment, and molybdenum content as previously shown in Figs. 5 through 7. Here results were obtained by extended field tests but with the same results.

Results of a 247-day exposure in an ammonium base sulphite digester are given in Table III. The interesting thing here is that, given a 2.5% molybdenum content, the greatest increase in corrosion resistance is obtained by raising the chromium content,

Table III. Exposure in Ammonium-Base Sulphite Digester for 247 Days

Type	Heat treatment	% Mo	% Cr	Corrosion (IPY)
0.03% max. C type 316	Mill annealed—not welded	2.53	19.10	0.00015
0.03% max. C type 316	Mill annealed—not welded	2.56	17.50	0.00020
0.03% max. C type 316	Mill annealed—not welded	2.56	16.52	0.00030
0.03% max. C type 316	Mill annealed—not welded	2.48	16.16	0.00039
0.03% max. C type 316	Mill annealed—not welded	2.80	16.32	0.00044
Hastelloy C	Mill annealed—not welded	16.76	15.05	0.00525
0.03% max. C type 316	Weld longitudinal bead—heat treat—1650°F. then weld transverse bead	2.80	18.52	0.00024
0.03% max. C type 316	Weld longitudinal bead—heat treat—1650°F. then weld transverse bead	2.95	18.09	0.00028
0.03% max. C type 316	Weld longitudinal bead—heat treat—1650°F. then weld transverse bead	3.20	16.96	0.00035
Hastelloy C	Mill stabilized stock. Cross welded specimen	17.62	13.95	0.054

Fig. 12. Intergranular corrosion of aluminum-bronze alloy exposed to steam at 600°F.

The dark band around the grains at the crack represents a zone of pure copper resulting from dealuminification.

Accelerated corrosion of carbon steel sulphate digesters, often accompanied by preferential attack at the weld, is becoming more and more of a problem. Figure 22 shows three submerged arc-welded specimens exposed 7000 hours in the liquid zone of a sulphate digester.

METALLURGICAL CONSIDERATIONS

In the previous discussion metallurgical information and corrosion data have been presented which are useful in the selection of suitable alloys for the fabrication of equipment for wood pulp manufacture. The corrosion data that have been presented are of further value since they cover fabrication treatments and welding which are of greatest importance in evaluating materials of construction. Our experience in testing has developed three types of specimens; namely (1) a specimen welded and representing a stress- or strain-free condition, (2) a specimen welded and constrained so as to estimate the effect of strain or stress, and (3) a specimen fabricated to simulate the manufacturing conditions used to construct useful equipment of the alloy.

Corrosion test specimens exposed in digesters must be of a rugged construction to withstand the service conditions and they must be installed at the important locations to give a complete picture of the process. The experience of the industry in the use of alloys around the digester has been mainly confined to castings for valves and piping and other accessories such as screens in the circulating systems. While the information derived from the experience in the use of such materials has been valuable, it cannot answer the question of the suitability of wrought alloys for welded fabrication purposes.

Our experience goes back to 1930 when a lined digester was fabricated for the Forest Products Laboratory at Madison, Wis. The users of austenitic stainless alloys at that time were just beginning to realize that these alloys could fail most completely in a service where carbon steel had been used with fair success. Carbide precipitation was the answer to many failures but in that first digester a stress-corrosion failure of the manway neck was experienced. The subsequent study of the failure increased the appreciation of the importance of strain and stress on the application of these alloys for the protection of carbon-steel equipment.

Fusion welding of these alloys accomplishes the prime purpose of a continuous corrosion protective surface, but it introduces a number of factors which must be well understood, such as the harmful effect on corrosion resistance caused by a localized heat zone, the stresses and strains resulting from high temperature on metal locally under constraint, and, of course, the ever present result of an alloy composition somewhat different in the weld metal from that in the alloy

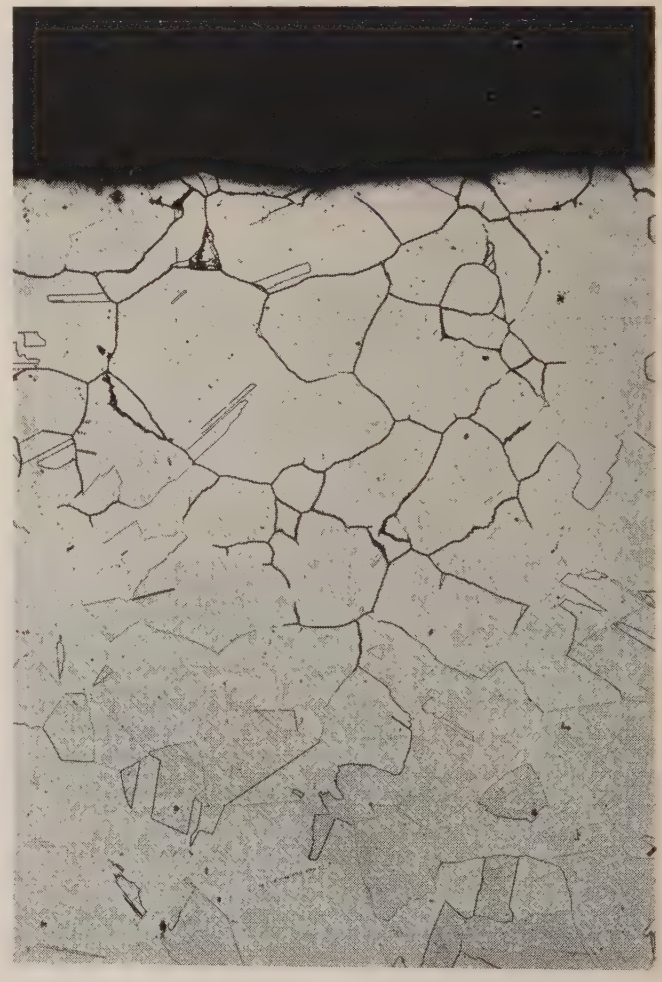

Fig. 13. Intergranular corrosion of pure nickel exposed in a strong caustic solution in treatment of sulphite waste liquor

Inconel, in spite of a fairly high-corrosion rate, was most satisfactory for this service.

joined and with an entirely different structure (cast) from the rolled sheets being joined.

Years of experience in testing have justified the use of welded construction with the proper application of metallurgical "know-how" and this varies for the different alloys. The fundamentals necessary to the proper fabrication of these alloys is fairly well understood and certainly it can be said that the control of quality necessary to maintain their best corrosion resisting properties is practiced so that it is possible to duplicate a fabricated alloy for a specific purpose.

The so-called accelerated laboratory tests for the selection of stainless alloys and the maintenance of high-quality fabrication procedures are a daily laboratory routine. No attempt is made to evaluate materials by these tests for a specific process unless that can be duplicated in the laboratory, but the tests do

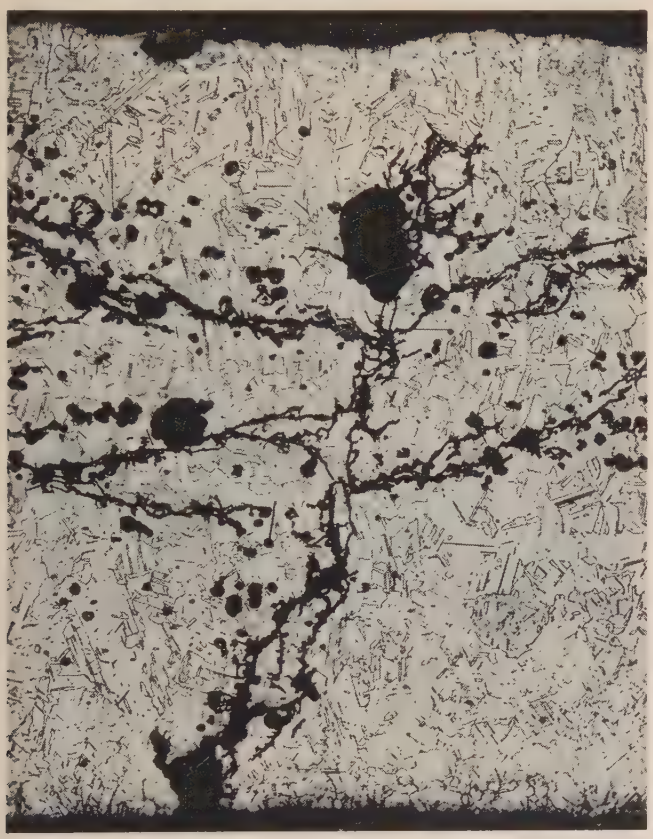

Fig. 14. Section through a type 347 boiling coil which showed severe stress corrosion and pitting

Annealing the replacement coil resulted in satisfactory life.

indicate when the standard procedures do not maintain the quality standards for the particular materials. A careful study of many alloys in the fabricated condition after long time field exposure tests has established the relationship between laboratory testing and field corrosion tests under normal process conditions. Such information is a long, time consuming process but eventually builds the foundation for the selection of satisfactory materials. It has been learned that it requires as much as 2 years of continuous exposure in the field testing programs to develop corrosion characteristics that may be duplicated by laboratory tests in a matter of 2 hours to 10 days. Experience teaches that field corrosion tests are, in general, of too short a duration usually to bring out all the process variables that can effect corrosion characteristics. There is a con-

Fig. 15. Severe stress corrosion cracking of inlet nozzle liner $^1/_4$ inch thick by $5^3/_4$ inches O.D. handling hot sulphate liquor

Annealing replacement nozzle liner at 1950°F. to remove welding and forming stresses resulted in satisfactory service.

stant search for improved laboratory tests and techniques which will duplicate some of the corrosion results brought out in the field testing programs as these are considered to be most valuable in assessing the merits of new alloys or modifications to existing alloy compositions.

The chemical process of wood digestion is and has recently been in a stage of revolution. Many are familiar with the modifications to the calcium bisulphite liquor, namely the ammonia base and magnesium base liquors. Studies have shown that the corrosion prob-

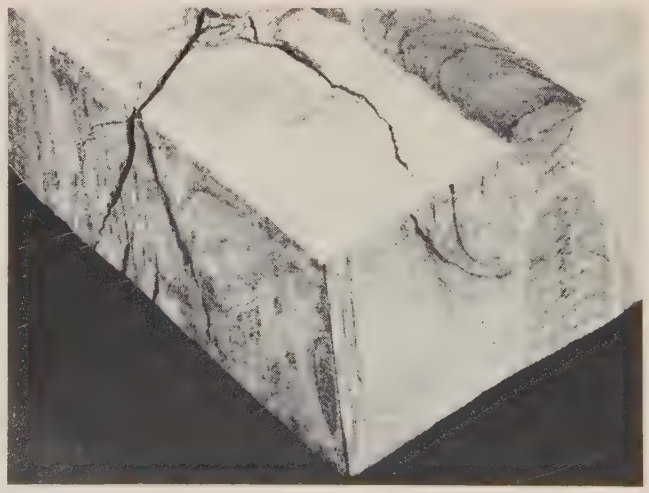

Fig. 16. Stress corrosion cracking through $1^1/_2$-inch wall of a type 347 autoclave handling 70% caustic at 525°F. Cutout shows shell to head circumferential weld

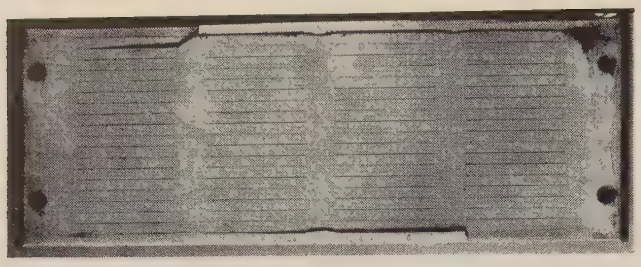

Fig. 17. Cracked type 304 vibrating screen. Annealing to remove forming stresses gave greatly increased life

lem is more difficult to solve with alloys especially on the recovery end of both new processes.

Of probably more recent interest is the modification to the alkaline sulphate process for the utilization of hardwoods. The new processes involve the use of an acid and basic liquor for the cook. The corrosion problems encountered with the duplex process eliminate some of the useful alloys used for either entirely acid or basic processes. Many alloys for the duplex process have been studied in a pilot plant operation and recently several lined digesters were manufactured for commercial use. After these digesters have been in operation several months, there will be much more data on several alloys which are in exposure.

Alloys for Lined Digesters

Alloy-lined equipment produced for the industry in the past three years has been manufactured with applied linings or clad-alloy plates as protection for the carbon steel.

The use of 11 to 13% chromium iron has been confined to the alkaline sulphate process.

Type 347 stainless (18–8 Cb) and types 316 and 317 with restricted carbon analysis have been used for both alkaline sulphate and acid sulphite processes.

Inconel has been considered favorable for the alkaline sulphate process only, and this material has several desirable characteristics and some advantages over type 347.

In general, types 316 or 317, the molybdenum bearing chromium-nickel stainless steel, have been found to be satisfactory for the acid sulphite processes.

Modifications of the 317 alloy with higher nickel, chromium, and the addition of copper shows promise of value in the acid processes. In general these alloys have found satisfactory use in sulphuric acid service and have demonstrated a very adherent protective film under adverse velocity conditions which prompts their investigation for digester service.

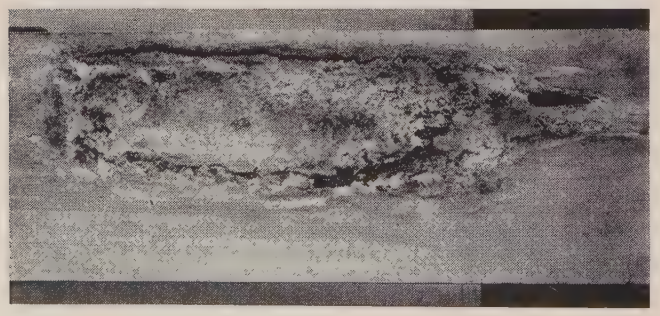

Fig. 18. Severe local corrosion of type 316 liner caused by direct impingement of SO_2 gases containing entrained sulphuric and sulphurous acid

New alloys of promise contain either high chromium above 25% with other additions or high-nickel alloys with substantial chromium, molybdenum, and other additions. These new materials are not commercially available at present but are being intensively studied for service requiring extreme resistance to pitting. There are indications that there may be a selection of alloys available to withstand strong bleaching service.

Lined Digesters and Acid Storage Tanks

After nearly three years of operating experience with lined digesters both in alkaline and acid service and about ten years' experience with lined acid-storage tanks and sulphur dioxide coolers, certain fundamental questions have been answered which have added to the general knowledge of alloys for this service.

Erosion-Corrosion. Tests of type 316 low-carbon alloy in a large sulphite digester exposed in the bottom cone have shown no measureable wear in 2 years' service. A similar experience has been indicated for type 347 in the lower portion of sulphate digesters.

Fig. 19. Erosion corrosion at tee joint handling hot sulphate liquor caused by poor fit up resulting in lack of fusion at root of weld

In sulphate digesters employing steam injection for cooking, it has been observed that the upper course of type 347 lining may be subject to "patchy" corrosion. It is believed that the path of steam, directed from the bottom head, channels through the charge and is directed near the vapor-liquor phase causing certain areas of corrosion. This appears to be a question of design and can be eliminated.

Liquor pump velocity in circulating systems for alkaline sulphate digesters appears to be somewhat critical on type 347 alloy. This condition will be corrected by proper baffling or lowering of pump velocity.

Organic Deposits—Contact Corrosion. The frothing of the charge can produce a coating on the vapor space of the lining consisting of tars, resins, and wood fines which if allowed to accumulate will bake to a hard resinous coating. This can effect the pitting resistance of stainless steels and for best results such deposits should be removed.

It has been observed in several large specimens exposed in the alkaline process that calcite ($CaCO_3$)

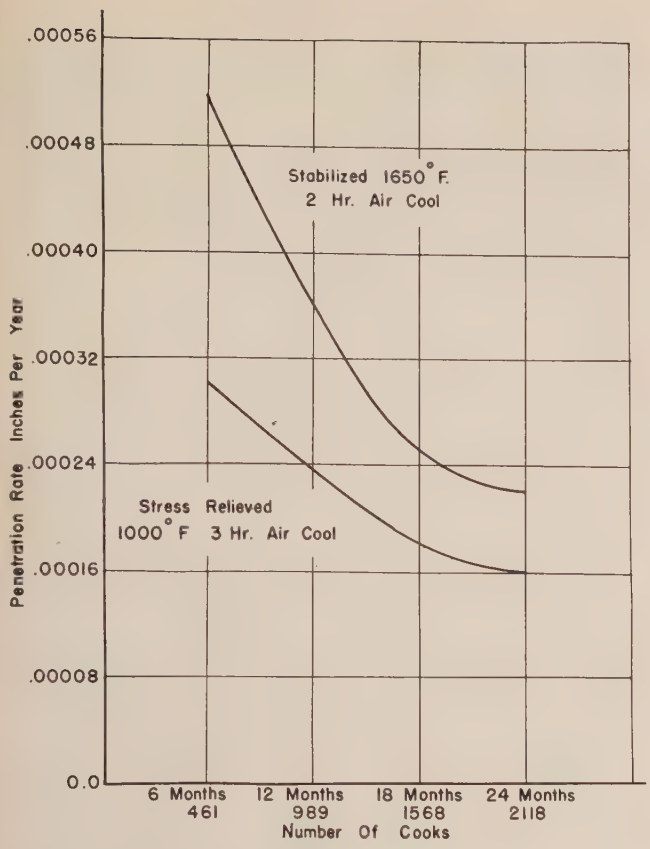

Fig. 20. Corrosion penetration rates of type 316 l. c. stainless steel in Smithlined sulphite digester No. 8

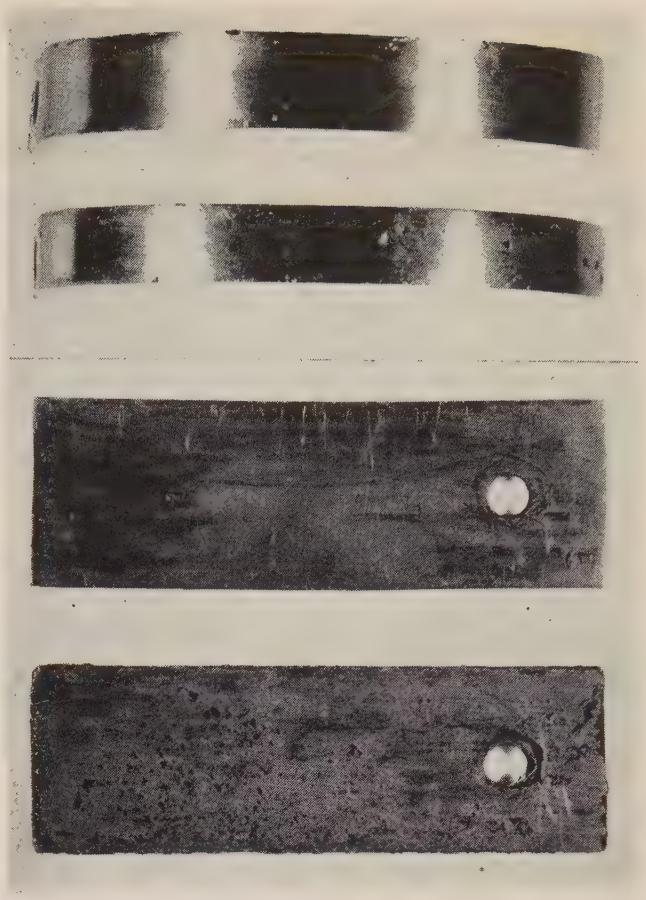

Fig. 21. Effect of heat treatment (top) and carbon content (bottom) on pitting tendency

Top	TOP	Bottom
Very slight pitting		Pitted
Mill annealed		2100°F. Slow cool

25% chrome 20% nickel
12000 hr. in sulphite digester

Top	BOTTOM	Bottom
No pits		Sugared and pitted
	1250°F. 2 hr.	
0.02% C		0.08% C

Type 316
2400 hr. in sulphite digester

forms more readily on the 11 to 13% Cr alloy than on 18–8. Such deposits are known to be protective for carbon steel when the deposit is unbroken but can act galvanically when punctured to cause excessive local attack.

Crevice Corrosion. It has been observed in the acid sulphite process that mating surfaces of the 18–8 alloys should be kept apart to prevent packing of the pulp and subsequent corrosion. Where circulating screens are employed, it is good practice to eliminate small openings which will prevent pitting attack and stress-corrosion cracking.

Stress—Corrosion. The austenitic stainless alloys are susceptible to cracking when cold worked (strained) or locally highly stressed such that a tension stress is present on the exposed surface of the alloy. Certain conditions in the chemistry of both the acid and alkaline processes for digestion can produce the correct corrosion environment to produce stress cracking.

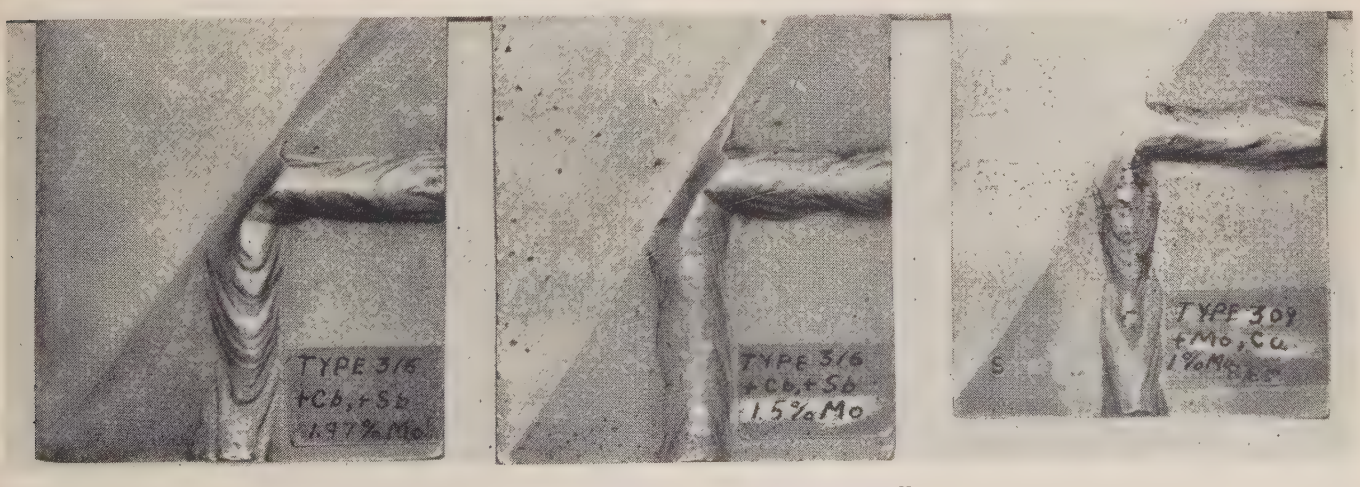

Fig. 21A. Effect of molybdenum content on alloys exposed 12000 hours in sulphite digester

The alkaline sulphate process which usually employs a mixture of white and black liquors and does not contain too high a sulphide content has been found to be relatively free from stress-corrosion cracking susceptibility.

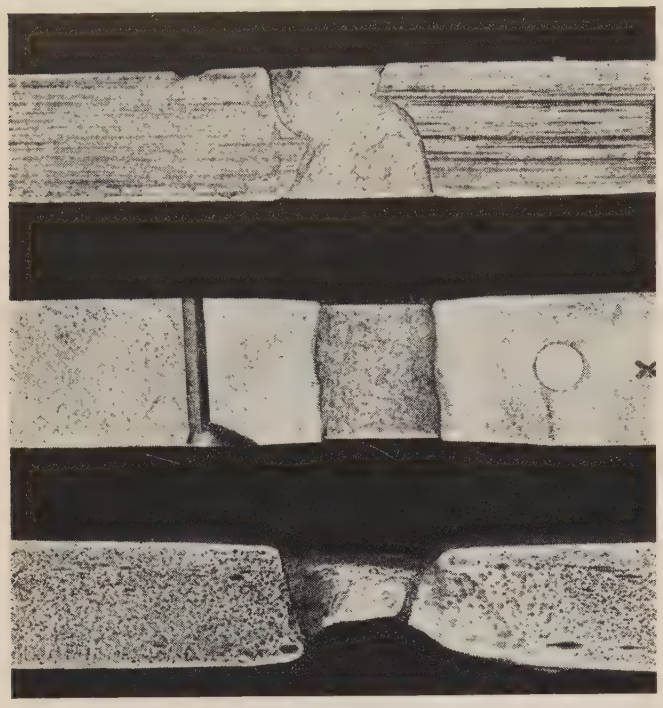

Fig. 22. Submerged arc-welded specimens exposed in liquid phase of carbon steel sulphate digester for 7000 hours

Top	ASTM A 212 and Oxweld 40, as welded
Middle	ASTM A 285 and Oxweld 36, as welded
Bottom	ASTM A 285 and Oxweld 36, stress relieved

Stress-corrosion tests made with laboratory chemicals in a water solution tested in bombs at 340 to 360°F. and 80 to 215 p.s.i. resulted in cracking of type 347 strained alloy when the following conditions were met: (1) high concentration of NaOH (expressed as Na_2O) 75 grams per liter with low Na_2S of about 5 to 10 grams per liter, (2) high concentration of Na_2S over 100 grams per liter with over 10 grams per liter of NaOH, or (3) high concentration of NaOH over 300 grams per liter.

Commercial liquors tested in bombs without wood fibers showed stress-cracking tendencies on type 347 in the strained condition only when the NaOH (as Na_2O) was above 50 grams per liter and the Na_2S exceeded 20 grams per liter. Twelve different mixed liquors from different mills were used in evaluating various materials, and while these tests showed greater susceptibility toward stress corrosion cracking of the austenitic alloys than for Inconel or straight chromium alloys, there are other considerations such as general corrosion rate that must be considered carefully in the choice of alloys for highly concentrated white liquors.

Stress corrosion has occurred on lined portions of digesters operating in concentrated alkaline liquors as described when the customer welded a strainer support ring continuously over the lining of the manway. Circulation of concentrated liquor back of field applied liners could result in stress corrosion of the austenitic linings. Galvanic tests would indicate that serious corrosion to the carbon steel would result with circulation back of straight chromium stainless-iron or stainless-steel linings. One instance of a blow nozzle where only that portion of the digester was lined with straight chromium iron confirmed the galvanic tests by showing accelerated corrosion attack of the carbon steel due to a leak at the seal weld. No stress corrosion cracking resulted in the chrome iron which again confirms our laboratory tests. Figure 23 shows a cross section of the corroded nozzle after 8 years' service.

Weld Metal. In general all weld metals we have used to fabricate type 347 and 316 linings have been very satisfactory in comparison with the wrought alloy—where minute pin holes or crater cracks have been exhibited after several months of service these areas have been repaired and are satisfactory. Experience indicates that with the alloys now being used field welds can be made to accommodate changes in piping or the addition of internals to the lining without adverse effects to the corrosion resistance of the liners.

Intergranular Attack. Field corrosion tests in both alkaline and acid service have indicated that the 18–8 type alloys are susceptible to intergranular attack when the alloy presents precipitated carbides. The degree of attack is greatest in the vapor zone of either process. The use of alloy free from any surface carbon pick up during manufacture is essential. There are several methods of detecting harmful carbide precipitation and such inspection methods are readily adaptable for the manufacture of sheets of alloy for lining purposes.

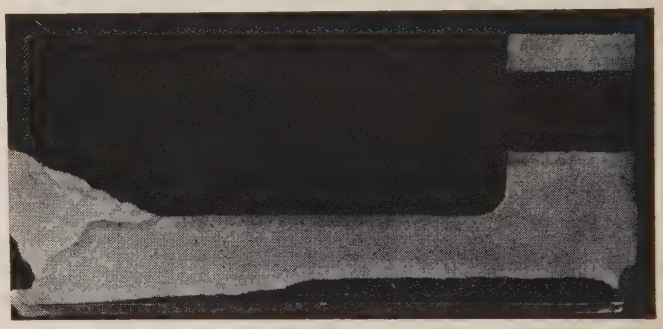

Fig. 23. Galvanic corrosion of carbon steel at ends of a straight chromium-iron lined blow nozzle from a sulphate digester

Accelerated attack took place behind the liner after galvanic corrosion caused circulation behind the liner.

Advantages of Alloy-Lined Equipment. The users of alloy equipment have reported that they are producing a higher quality pulp with greater economy in cooking time and liquor consumption than has heretofore been obtainable. It is too early to state definitely at this time the full realization of all the economies possible with the alloy digesters.

Where alloy lined digesters have been installed to replace older equipment, it is possible to increase the capacity for a given space requirement due to about 20% added capacity because of the thinner wall requirements of alloy linings over brick linings.

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The Effect of Sodium Peroxide Bleaching on the Components of Eastern Spruce Groundwood

GARY W. JONES

The present investigation has resulted in several general conclusions concerning the effect of sodium peroxide bleaching upon eastern spruce groundwood. These conclusions have particular reference to a typical 2% sodium peroxide bleach (calculated on the basis of the moisture-free pulp) at approximately 5% consistency. They are as follows: As evaluated in terms of current wood analysis procedures, sodium peroxide bleaching does not cause any large-scale chemical changes in the known components of spruce groundwood. During a normal groundwood bleaching operation, the total lignin is responsible for about 40% and the holocellulose for about 60% of the total sodium peroxide consumed. The ether and ethanol extractives are of minor importance with regard to an over-all peroxide consumption balance, since they apparently are accountable for only 1 to 4% of the total peroxide consumption. Optical data that suggested qualitatively, the major bleaching effect exerted by sodium peroxide upon spruce groundwood can probably be attributable to its reaction with the lignin. It was found that methylation of isolated native lignin with diazomethane or with absolute methanol in the presence of hydrogen chloride markedly inhibits its reaction with sodium peroxide. Accordingly, it was deduced that sodium peroxide attacks lignin primarily through a portion of the carbonyl groups (and possibly the phenolic hydroxyl groups) in the lignin structure. Kinetic and analytical studies of the reaction between sodium peroxide and isolated native lignin indicated that lignin is composed of two or more fractions which are essentially the same in elementary composition and methoxyl content but which differ from each other with respect to their intrinsic color and chemical reactivity toward sodium peroxide. It was suggested that the bleaching action of sodium peroxide upon spruce groundwood may be the result of a chemical reaction between this reagent and the more highly colored lignin fractions. Furthermore, the remarkable efficiency of the bleaching action may possibly be attributable to a relatively high specificity on the part of sodium peroxide toward these particular fractions.

THE PULP and paper industry is currently showing intense interest in the application of sodium peroxide as a bleaching agent for wood pulp. During the past eight years, sodium peroxide bleaching processes have been developed for groundwood and for certain types of chemical and semichemical pulps. These processes have been recognized by the industry as being economically feasible and, at the present time, are being employed successfully on a commercial scale by a number of mills in the United States.

The history of the development of sodium peroxide bleaching has been reviewed in published articles by Reichert (*1*) and Stobo and Russell (*2*). The properties and uses of sodium peroxide-bleached mechanical pulps have been discussed by Beeman, Goodwill, and Shearer (*3*), Reichert (*4*), Rhodes (*5*), and Coleman (*6*). Reichert and co-workers (*7–9*) have studied a number of important variables of the sodium peroxide bleaching process. This subject has also been investigated by Stobo and Russell (*2*). The commercial application of sodium peroxide bleaching is described by Reichert (*4*), Ullman (*11*), Coleman (*6*), and Lee (*12, 13*).

In the past, virtually all research associated with sodium peroxide bleaching has been directed solely toward the development of optimum bleaching conditions and other practical aspects of the subject. Thus, in spite of the tremendous advances that have been made in the technology of sodium peroxide bleaching, a fundamental understanding of the process has not yet been reached.

The present work comprises a fundamental study of sodium peroxide bleaching as it is applied to spruce groundwood. Its purpose is to obtain knowledge concerning the chemical changes that are brought about in eastern spruce groundwood when that pulp is subjected to a typical sodium peroxide bleaching operation. Particular attention is directed toward those changes which are thought to be associated with the bleaching action of the peroxide.

RAW MATERIALS

Groundwood Pulp

Eastern spruce groundwood served as the primary raw material for the present study. This pulp was chosen because of its local availability and because it represents a mechanical pulp that is commonly bleached with sodium peroxide. It was obtained from a local mill either as fresh lap less than 24 hours old or as slush pulp less than 4 hours old. A microscopic examination of this pulp indicated that it contained no traces of hardwood.

Holocellulose

The holocellulose used in the present work was prepared by Bublitz (*14*) from black sprucewood meal (8-48 mesh) which had previously been extracted with alcohol-benzene. Sodium chlorite was used as the delignifying agent. The particular sample employed in the present work was ground in a small Wiley mill until it passed a 60-mesh screen. The methoxyl content was 1.75% and the Klason lignin, 1.9%.

GARY W. JONES, Consolidated Water Power & Paper Co., Stevens Point, Wis. A portion of a thesis submitted in partial fulfillment of the requirements of The Institute of Paper Chemistry for the degree of Doctor of Philosophy from Lawrence College, Appleton, Wis., June, 1948. This work was carried out under the direction of M. A. Buchanan.

Isolated Native Spruce Lignin

The isolation of native lignin from black sprucewood meal has been reported by Brauns (*15*). He defines extractable native lignin as that portion of the lignin in wood which can be isolated (in an unchanged state) by extracting the wood with organic solvents without the use of acids or alkalies.

In the present work, three samples of isolated native lignin were prepared from eastern spruce groundwood according to procedures that were similar to the one employed by Brauns. Two of these samples were obtained by extracting the unbleached groundwood. In one case the extraction was carried out with 95% ethanol and, in the other case, Methyl Cellosolve was employed. The third sample of isolated native lignin was prepared by extracting bleached (2% sodium peroxide) groundwood with Methyl Cellosolve. All three products were purified essentially according to Brauns' procedure— i.e., by at least two precipitations into distilled water, followed by at least three precipitations from anhydrous 1,4-dioxane into ethyl ether. After each precipitation into ether, the products were washed thoroughly with petroleum ether. The products were dried in a vacuum desiccator over concentrated sulphuric acid.

Brauns proposed a unit molecular weight of 840 for his isolated native lignin. The unit molecular weights of the three products prepared in the present work have been calculated according to Brauns' method, and are included, with the analytical data for these materials, in Table I. It will be noted that these products, as evaluated in terms of chemical analyses and unit molecular weights, are very similar to the isolated native spruce lignin prepared by Brauns.

Table I. Chemical Analyses of Isolated Native Spruce Lignins[a]

	Ash, %	*Methoxyl, %*	*Carbon, %*	*Hydrogen, %*	*Unit molecular weight*
1. Native lignin isolated by ethanol extraction of unbleached spruce groundwood	0.32	15.4	64.5	5.96	805
2. Native lignin isolated by Methyl Cellosolve extraction of unbleached spruce groundwood	0.40	15.0	64.3	5.82	826
3. Native lignin isolated by Methyl Cellosolve extraction of bleached spruce groundwood	0.86	15.1	64.1	5.84	822
4. Brauns' isolated native spruce lignin	....	14.8	63.9	6.19	840

[a] The analyses of products 1, 2, and 3 are expressed on an ash-free basis.

ANALYTICAL METHODS

Groundwood pulps were analyzed according to methods essentially the same as the TAPPI Standards.

In a recent publication, Purves and co-workers (*16*) offered experimental evidence that oven drying at 105°C. results in a marked decrease in the carbon content of lignin isolated according to the Klason procedure (72% sulphuric acid). Since reliable analytical data were essential for confident interpretation of the present studies on isolated native lignin, it was considered a matter of primary importance to determine the effect of oven drying upon this material and to develop a suitable method for preparing samples for chemical analysis. A series of experiments performed for this purpose indicated that oven drying at 105°C. does not alter the elementary composition of isolated native lignin. However, it was found undesirable to analyze oven-dry samples of the lignin because such samples have a strong tendency to absorb atmospheric moisture during the analysis.

During the course of the above experiments, several methods were used for determining the moisture content of air-dry isolated native lignin. Samples of this material were dried to constant weight in a vacuum desiccator (room temperature) over phosphorus pentoxide in a vacuum oven at 60°C. and in an ordinary oven at 105°C. It was found that all three drying methods resulted in essentially the same apparent moisture content for the isolated native lignin.

As a result of the above study, it was found desirable to analyze isolated native lignin in an air-dry state and correct the analyses for the predetermined moisture content. The following procedure was adopted for preparing lignin products for chemical analysis:

Approximately 0.25 gram of the material to be analyzed was placed in a small, tared weighing bottle, pulverized with a stirring rod or small spatula, and then exposed to an atmosphere of approximately 100% relative humidity for a period of 24 to 48 hours. This humidification procedure was carried out in an evacuated desiccator containing a dish of distilled water. The sample was next transferred to a vacuum oven and dried to constant weight at 60°C. Finally, the sample was exposed to the atmosphere for a period of approximately 24 hours and the resulting air-dry weight of the sample determined. This air-dry material was used for chemical analyses, the gain in weight (from the oven-dry to the air-dry state) being taken as its moisture content.

The primary advantage of the above procedure is that it requires only a small amount of lignin. The humidification step tends to lessen (and in many cases to eliminate) the electrostatic charge that frequently develops on isolated lignins. Humidification, followed by drying, is of value in removing organic solvents from many materials.

Methoxyl determinations were carried out on lignin products according to a semimicro modified Zeisel procedure. A modified Pregl microcombustion method was employed for all elementary analyses.

The procedure of TAPPI Standard T 218 was employed to prepare handsheets for optical tests, except that the British sheet mold was used to obtain better formation. Brightness tests on groundwood handsheets were carried out with a G. E. reflection meter. The spectral reflectance curves for groundwood handsheets were determined by means of a G. E. recording spectrophotometer. This instrument was also used to measure the spectral transmittance of dioxane solutions of isolated native lignin.

Solutions of sodium peroxide were analyzed as follows. An aliquot of the solution was pipetted into

approximately 20 ml. of 10% sulphuric acid. Approximately 1 gram of potassium iodide and 3 drops of ammonium molybdate solution were then added. The liberated iodine was titrated with standard sodium thiosulphate solution, using starch-iodide indicator for determining the end point. The sodium peroxide concentration was then calculated and expressed as grams per liter.

Unless specified otherwise in the individual cases, all sodium peroxide consumption tests were carried out at 32°C. and the initial concentration of sodium peroxide was 1 gram per liter. (This is the same as the peroxide concentration at the start of a typical groundwood bleach carried out at 5% consistency with 2% sodium peroxide.) The stock bleach liquors for these tests contained the same amounts of sodium silicate, Epsom salt, and sulphuric acid that are normally employed in preparing stock liquors for bleaching groundwood.

All peroxide consumption tests were carried out essentially according to the following procedure:

A sample of the material to be tested was weighed into a beaker of suitable size and diluted with an amount of distilled water that was equal to the total desired volume less the calculated amount of bleach liquor. The suspension was stirred mechanically until a finely divided product was obtained. The beaker containing the suspension was placed in a constant temperature bath and, after the suspension had attained the required temperature, the calculated amount of stock bleach liquor was added. Aliquots of the solution were titrated at appropriate time intervals and, from these data, the rate of sodium peroxide consumption was calculated.

EXPERIMENTAL PROCEDURE AND RESULTS

Preparation and Analysis of Bleached Groundwood

Samples of spruce groundwood were bleached with varying amounts of sodium peroxide. The results indicated that the groundwood responded in a normal fashion to peroxide bleaching.

Two samples of groundwood were prepared for control purposes. One was diluted, drained, pressed, and dried without the addition of any chemicals. The other was treated with all the bleaching chemicals except sodium peroxide. The proper alkalinity was maintained by the substitution of a suitable amount of sodium hydroxide.

Based on the oven-dry weight of the groundwood pulp, the amount of sodium silicate (40° Bé. water solution) used in all bleaches was 5 ± 0.5%. In all cases, the active alkali, expressed as sodium oxide, was approximately 0.75% of the oven-dry weight of the pulp. The quantity of Epsom salt varied with the amount of sodium peroxide, always being present to the extent of 1.25% of the latter. The bleaching temperature was 32°C. and the consistency of the pulp was 5%. All pulps were bleached over a period of six hours. At the end of this time, the pH of the slurry was adjusted to approximately 5 by the addition of the necessary amount of distilled water saturated with sulphur dioxide. After the pulp had been allowed to stand for another two hours, a sample was removed for a brightness test. The slurry was then diluted to 0.5% consistency with tap water, drained through a muslin cloth, pressed to about 20% consistency, shredded, and finally dried in the open air.

The two control pulps and two bleached pulps were subjected to chemical analysis. These data are presented in Table II.

Table II. Analyses of Groundwood Pulps

Determination[a]	*Treatment of the pulp*			
	Water only	*Alkali only*	*2% Sodium peroxide*	*4% Sodium peroxide*
1. G. E. brightness	62.1	62.2	72.1	74.4
2. Ash, %	0.27	....	0.42	....
Extractives				
3. Absolute ether, %	0.48	0.53	0.50	0.53
4. Absolute ethanol, %	0.75	0.59	0.60	0.54
5. Hot water, %	0.74	0.46	0.64	0.65
6. 95% ethanol, %	0.47	0.50	0.38	0.38
7. Total extractives, %	2.44	2.08	2.12	2.10
Other Analyses				
8. Klason lignin, %	26.65	....	26.62	....
9. Klason lignin methoxyl, %	16.17	....	16.14	....
10. Pulp methoxyl, %	4.98	....	4.96	....
11. Acetyl, %	1.63	1.21	1.11	0.66
12. Pentosans, %	10.5	....	10.5	....
13. Uronic acid, %	1.19	1.18	1.27	1.09
14. Organic acidity, %	0.37	0.38	0.53	0.48

[a] The values for determinations 2 to 14 are not corrected for the ash content of the pulp. Determinations 8 through 14 are calculated on an extractive-free basis.

Sodium Peroxide Consumption by Extractives and Isolated Native Lignin

The analytical data obtained for the unbleached and bleached pulps suggested that, during a normal bleaching operation, sodium peroxide reacts with at least a portion of the ethanol-soluble materials in spruce groundwood. Therefore, the effect of sodium peroxide upon the ethanol- and ether-soluble components of groundwood was studied further by testing the capacity of these materials (in the isolated state) to consume sodium peroxide. Two tests were run on the alcohol extract, one at 1 gram per liter and the other at 0.25 gram per liter of sodium peroxide. In both cases the concentration of the alcohol extract was 0.55 gram per liter. One test was carried out on the ether extract, the concentration of the extract being 1 gram per liter. It is notable that the extracts dissolved immediately when the stock bleach liquor was added. The results of these tests are presented in Figs. 1 and 2.

Since extractable native lignin comprises an appreciable portion of the alcohol-soluble material in groundwood, the course of investigation was next directed toward a study of the effect of sodium peroxide upon this groundwood component. Sodium peroxide consumption tests were made on native lignin which had been extracted from spruce groundwood with Methyl Cellosolve (product 2, Table I). These tests were carried out at three different concentrations of

isolated native lignin. In all cases, the lignin was found to be completely soluble in the peroxide bleach liquor. The results of these tests are plotted in Fig. 3 as curves 1, 2, and 3.

Preparation of Bleached Isolated Native Lignin

A sample of isolated native lignin (product 1, Table I) was bleached with sodium peroxide under the following conditions:

Isolated native lignin, g./l.	1.0
Sodium peroxide, g./l.	1.0
Temperature, °C.	32
Initial pH	11.0

The lignin was dissolved in the bleach liquor according to a procedure that was essentially the same as that which has been described for running peroxide consumption tests. At the termination of the 6-hour bleaching period, the excess sodium peroxide was destroyed with sodium bisulphite, and the pH of the solution was adjusted to about 3.5 with dilute sulphuric acid. The light-colored lignin which precipitated was allowed to settle for two hours before it was separated from the supernatant solution by centrifugation. It was then purified by repeated precipitations into water and then into ether. The purified product was much lighter in color than the original lignin. It was designated as fraction A.

The supernatant solution, from which fraction A had been removed, was adjusted to pH 6 with dilute sodium hydroxide and then concentrated by vacuum distillation to about 5% of its original volume. A flocculent precipitate of inorganic salts was removed by vacuum filtration. Acidification of the filtrate to pH 3.5 caused the precipitation of a ligninlike material that was separated from the solution by centrifugation. This product was purified by precipitating twice into ether. The resultant material was rather dark in color. It was designated as fraction B.

The supernatant solution, from which fraction B had been removed, was saturated with sodium sulphate and extracted with 1:1 acetone-methyl acetate. The extracted material was purified by precipitating three times into ether. The resultant product was quite dark in color. It was designated as fraction C.

The chemical analyses of fractions A, B, and C and the original unbleached lignin are listed in Table III. The yield figures are only approximate because the isolations were not carried out quantitatively.

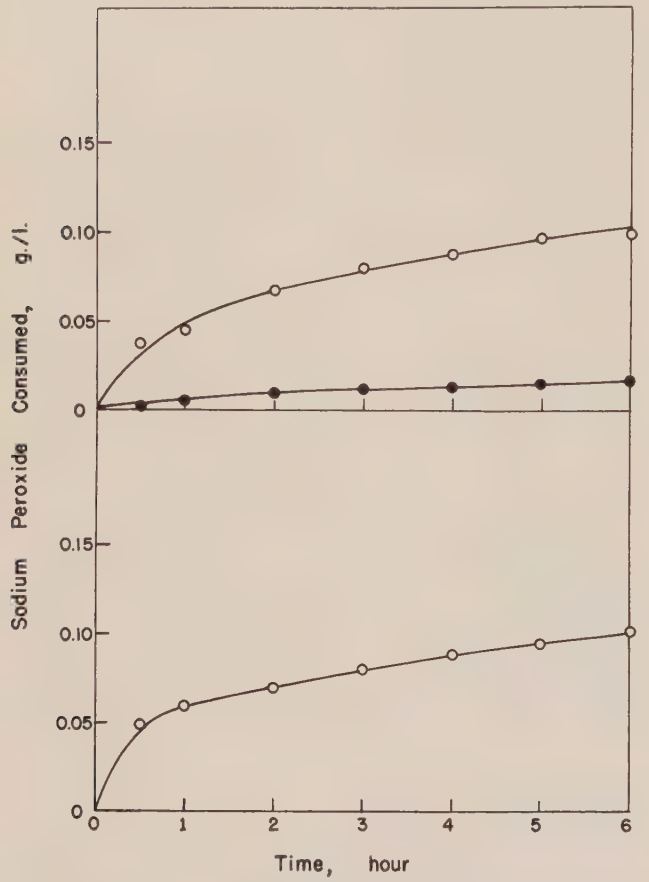

Fig. 1 (above). Sodium peroxide consumption by spruce ethanol extract

	(1)	(2)
Na_2O_2, g./l.	1.0	0.25
Extract, g./l.	0.55	0.55
Temperature, °C.	32	32

Fig. 2 (below). Sodium peroxide consumption by spruce ether extract

Na_2O_2, g./l.	1.0
Extract, g./l.	1.0
Temperature, °C.	32

Table III. Products of the Reactions Between Sodium Peroxide and Isolated Native Lignin[a]

Product	*Yield, %*	*Ash, %*	*Methoxyl, %*	*Carbon, %*	*Hydrogen, %*
Original native lignin	..	0.32	15.4	64.5	5.96
Fraction A	48	0.56	15.6	63.7	5.78
Fraction B	7	0.28	14.3	61.2	5.78
Fraction C	8	0.70	12.7	60.1	5.63
Fraction from waste bleach liquor	..	3.0	13.1	60.3	5.60

[a] All analyses are expressed on an ash-free basis.

The effect of bleaching time upon isolated native lignin was investigated by bleaching two samples of this material for two and six hours, respectively. The bleaching procedure was essentially the same as the one described above. Only the fraction A products were isolated, during which care was taken to prevent loss of material. Both products were lighter in color than the original isolated native lignin. The results of this experiment are summarized in Table IV.

Table IV. The Effect of Bleaching Time on the Chemical Analysis of Isolated Native Lignin[a]

Bleaching time, hr.	*Yield, %*	*Ash, %*	*Methoxyl, %*	*Carbon, %*	*Hydrogen, %*
0	..	0.32	15.4	64.5	5.96
2	67	0.22	15.2	64.2	5.88
6	62	0.25	15.6	63.8	5.74

[a] All analyses are expressed on an ash-free basis.

A sodium peroxide consumption test was carried out on the lignin that had been bleached for two hours. The concentration of the bleached lignin was 1 gram per liter. The peroxide consumption curves for this

lignin and for unbleached isolated native lignin are plotted in Fig. 4.

The foregoing experiments demonstrated that, under conditions simulating groundwood bleaching, isolated native lignin reacts quite readily with sodium peroxide. It is probable, however, that the experimental conditions were somewhat more drastic than those which

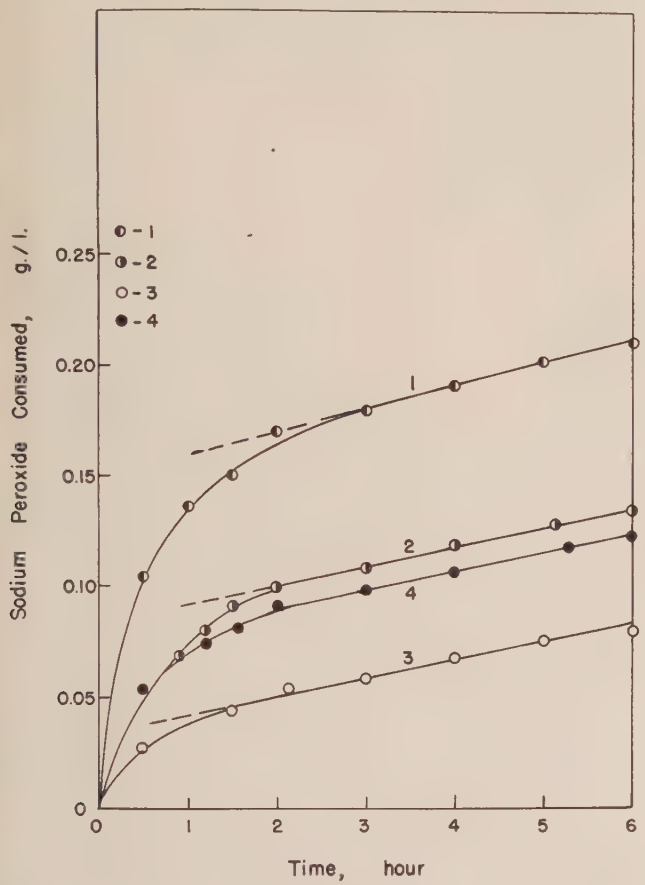

Fig. 3. Sodium peroxide consumption by isolated native spruce lignin

Curve	*Native lignin, type*	*Native lignin, g./l.*	*Na_2O_2 g./l.*
1	Unbleached	2.0	1.0
2	Unbleached	1.0	1.0
3	Unbleached	0.5	1.0
4	Bleached	1.0	1.0

actually exist during a groundwood bleach. An isolated native lignin which had been bleached under the actual conditions of groundwood bleaching was prepared by extracting spruce groundwood which had previously been bleached with 2% sodium peroxide with Methyl Cellosolve. The corresponding unbleached product was obtained by extracting unbleached groundwood with the same solvent. The product obtained from the bleached groundwood was found to be considerably lighter in color (as a solid and in dioxane solution) than that prepared from the unbleached groundwood. The chemical analyses of the unbleached and bleached lignins are listed in Table I as products 2 and 3, respectively. It will be noted that the chemical analyses of these two lignins are essentially identical.

Ultraviolet absorption spectra were determined on dioxane solutions of these products. These spectra were found to be virtually identical and were the same as the ultraviolet absorption spectrum obtained by Barton (*17*) for isolated native spruce lignin.

The sodium peroxide consumption curves for these products are plotted in Fig. 3 as curves 2 and 4.

Examination of the Waste Bleach Liquor

A sample of spruce groundwood was bleached at 5% consistency with 2% sodium peroxide. At the termination of the two-hour sulphur dioxide neutralization stage, the spent bleach liquor was collected and concentrated to approximately 5% of its original volume by vacuum distillation. The concentrated liquor was extracted with a mixture of dioxane and acetone. The extracted material was purified by repeated precipitations from anhydrous dioxane into ethyl ether. A 0.1% yield (based on the oven-dry weight of the original groundwood) of a reddish-brown

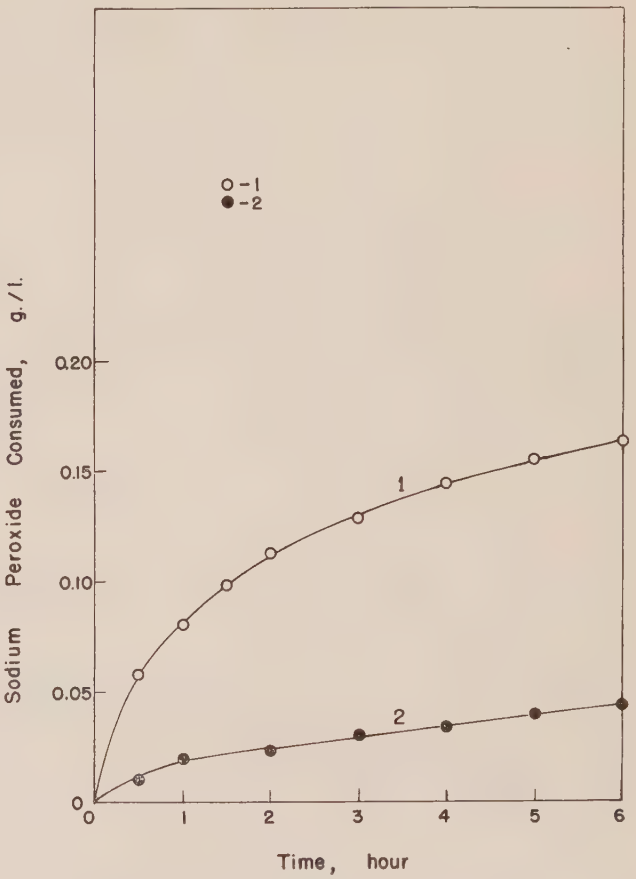

Fig. 4. Sodium peroxide consumption by bleached native lignin

1 Unbleached
2 Bleached (2 hr.)
Na_2O_2, g./l..... 1.0
Native lignin, g./l..... 1.0
Temperature, °C.....32
Initial pH.....11.0

material was obtained. Its chemical analysis is listed as the last item in Table III.

The Effect of Methylation Upon Sodium Peroxide Consumption by Isolated Native Spruce Lignin

Brauns (*15, 18*) has proposed that spruce lignin contains phenolic hydroxyl groups and readily enoliz-

able carbonyl groups, both of which are capable of selective methylation with certain reagents. His concepts have been employed in the present work to determine the possible role of these groups in the peroxide bleaching process.

The three methylated derivatives which were prepared in the present work are listed in Table V. Derivative I was prepared by methylating isolated native lignin (product 2, Table I) in anhydrous ether suspension with a large excess of diazomethane. Derivative II was prepared by treating isolated native lignin (product 1, Table I) with anhydrous methanol and hydrogen chloride according to the method of Brauns (*15*).

Derivative III represents an attempt to methylate only the phenolic hydroxyl groups in lignin. Four methylations were carried out on a sample of isolated

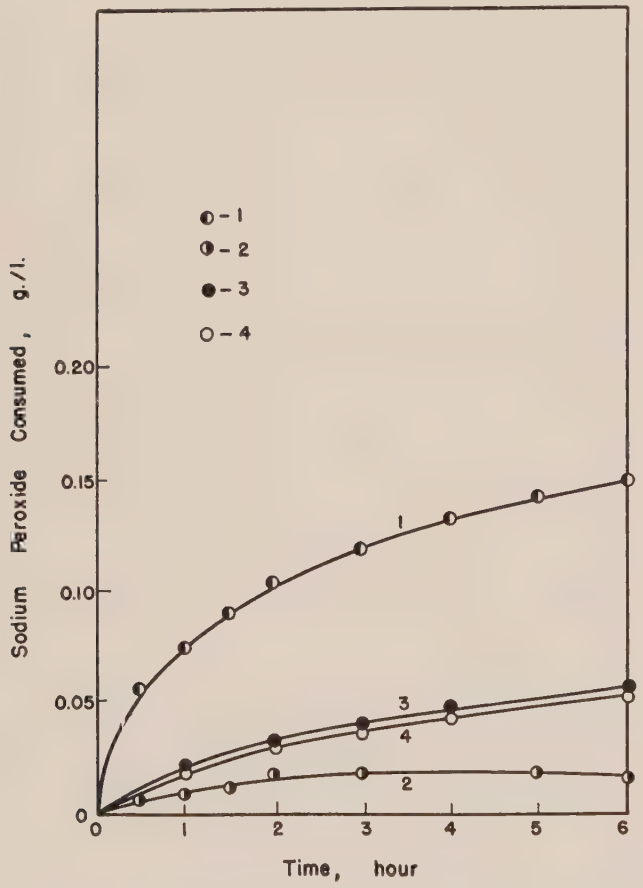

Fig. 5. Sodium peroxide consumption by methylated derivatives of isolated native lignin

1 Unmethylated
2 Phenolic and enolic hydroxyls essentially completely methylated
3 Carbonyl group completely methylated
4 Phenolic and enolic hydroxyls approximately 50% methylated

Na_2O_2, g./l.	1.0
Lignin derivatives, g./l.	1.0
Temperature, °C.	32
Initial pH	11.0

native lignin (product 1, Table I), each methylation being made with a quantity of diazomethane that was 10% in excess of the amount required to complete the methylation of one hydroxyl group per unit molecular weight of the lignin. The methoxyl content of the lignin was increased from 15.4 to 18.7%, this increase representing the introduction of 0.93 methoxyl group per unit molecular weight of lignin. A sample of this

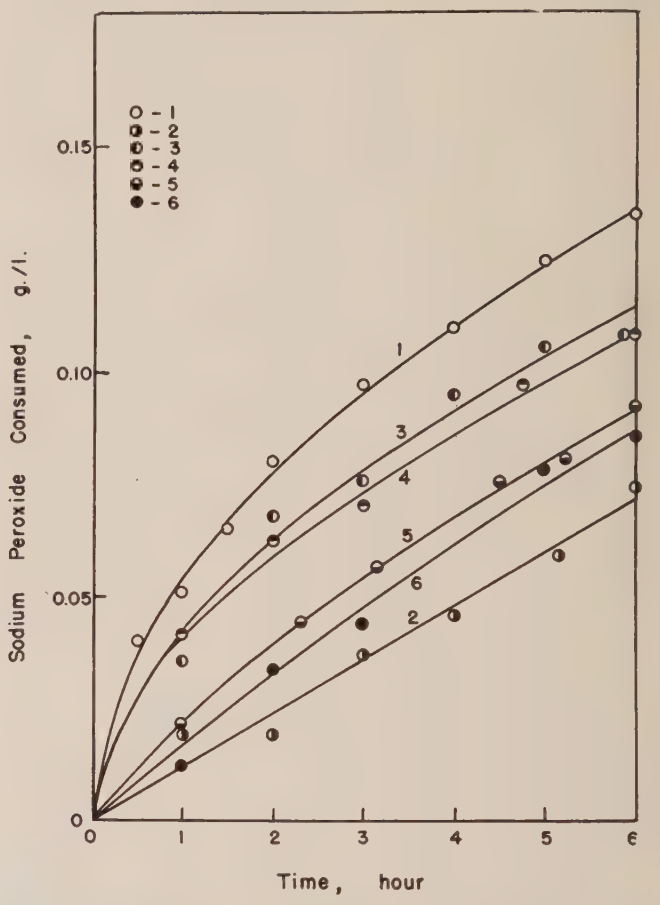

Fig. 6. Sodium peroxide consumption by groundwood and holocellulose and their methylated derivatives

1 Unmethylated groundwood
2 Methylated groundwood
3 Unextracted holocellulose
4 Extracted holocellulose
5 Methylated holocellulose
6 Remethylated holocellulose

product was treated with anhydrous methanol and hydrogen chloride, and the methoxyl content of the lignin was increased to 23.6%. From these data, it can be calculated that the diazomethane methylation

Table V. Methylated Derivatives of Isolated Native Lignin

Derivative	*Description*	*Methoxyl, %*	*Sodium peroxide consumption curve (Fig. 6)*
	Unmethylated	15.4	1
I	Phenolic and enolic hydroxyls essentially completely methylated	20.7	2
II	Carbonyl group completely methylated	21.9	3
III	Phenolic and enolic hydroxyls approximately 50% methylated	18.7	4

covered approximately half the phenolic hydroxyls and half the carbonyl groups (in the enolic form).

Using essentially the above procedure, Brauns (*15, 18*) carried out a methylation that apparently was specific for the phenolic hydroxyl group. The failure to do so in the present case may have resulted from traces of water, small amounts of methylamine in the diazomethane, or a combination of both.

Sodium peroxide consumption tests were run on the three methylated derivatives of isolated native lignin.

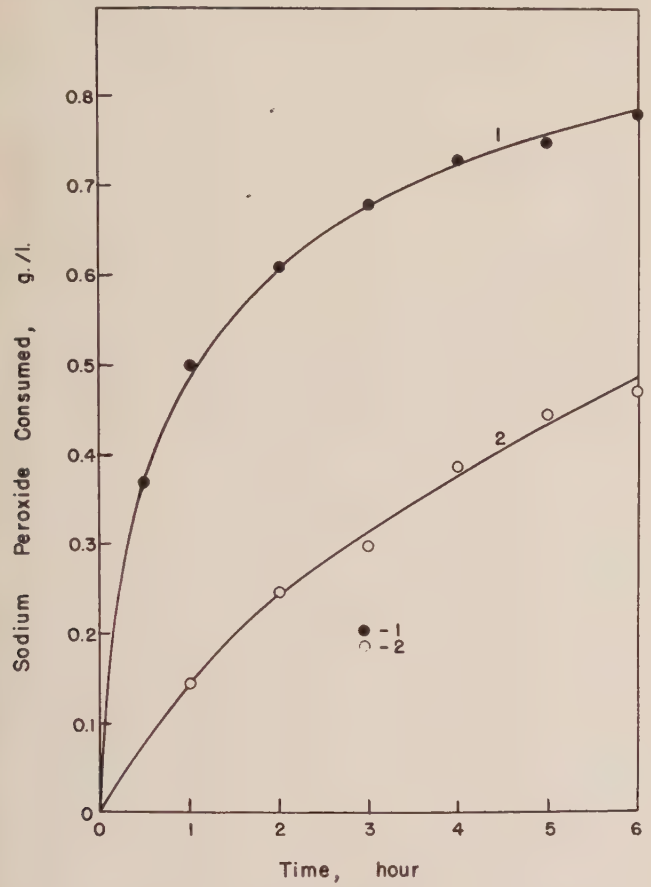

Fig. 7. Sodium peroxide consumption by groundwood at 5% consistency

1 Unmethylated groundwood
2 Methylated groundwood
Na_2O_2, g./l..... 1.0
Consistency, %..... 5.0
Temperature, °C.....32
Initial pH.....11.0

In all cases the lignin concentration was 1 gram per liter. It is notable that derivative I was insoluble in the peroxide bleach liquor. Derivatives II and III, however, were soluble. The results of these tests are plotted in Fig. 5.

The Effect of Methylation Upon Sodium Peroxide Consumption by Spruce Groundwood and Holocellulose

A sample of unbleached spruce groundwood was ground in a small Wiley mill until it passed an 80-mesh screen. It was then methylated in anhydrous ether suspension with diazomethane. Two methylations were carried out over a period of 10 days, a large excess of diazomethane being used each time. The methoxyl content of the pulp was raised from 4.98 to 7.94%.

Sodium peroxide consumption tests were carried out on samples of the methylated and unmethylated groundwood. In each case, the concentration of the groundwood was 3.75 grams per liter. The results of these tests are plotted in Fig. 6 as curves 1 and 2.

Sodium peroxide consumption tests were also run on the methylated and unmethylated groundwood at a pulp consistency of 5%. The results of these tests are plotted in Fig. 7.

A sodium peroxide consumption test was carried out on a sample of isolated holocellulose. The concentration of the holocellulose was 2.75 grams per liter. This concentration represented the amount of holocellulose that was present in the groundwood when the latter was tested at 3.75 grams per liter. The peroxide consumption by the isolated holocellulose is plotted in Fig. 6 as curve 3.

A sodium peroxide consumption test was also carried out on a sample of holocellulose that had been extracted with dilute ethanol. The concentration of the holocellulose was 4.91% less than in the case of the first test on isolated holocellulose. This reduction in concentration was made because the extraction procedure had removed 4.91% of aqueous ethanol-soluble materials (and had lowered the methoxyl content of the holocellulose from 1.75 to 1.62%). The results of this test are plotted in Fig. 6 as curve 4.

A sample of extracted holocellulose was methylated twice in anhydrous ether suspension with diazomethane. The first methylation raised the methoxyl content from 1.62 to 1.87%. The sodium peroxide consumption curve for this product is represented by curve 5 in Fig. 6. The second methylation increased the methoxyl content of the holocellulose from 1.87 to 2.73%. The peroxide consumption by this product is represented by curve 6 in Fig. 6.

Optical Data

The spectral transmittances of dioxane solutions of unbleached and bleached isolated native lignin were measured over the visible range of light. The unbleached lignin was isolated by extracting unbleached groundwood with Methyl Cellosolve (product 2, Table I). The bleached lignin was isolated by extracting bleached groundwood with Methyl Cellosolve (product 3, Table I).

The specific absorption coefficients were calculated for these lignins by means of the logarithmic form of Beer's equation:

$$a = 1/cx \ln 1/T$$

where

a = the specific absorption coefficient, sq. cm./g.
c = the concentration of the lignin, g./cc.
x = the thickness of the transmittance cell, cm., and ln signifies natural logarithms (base e)

The calculated specific absorption coefficients for the two lignins are presented in Table VI, a_u representing the specific absorption coefficients of the unbleached lignin and a_b those of the bleached lignin.

Brightness handsheets were formed from samples of bleached and unbleached groundwood pulps. The values of R_0 (the absolute reflectance of a single sheet

backed by a black cavity) and R_∞ (the absolute reflectance of a sheet backed by a thick pad of the same material) were determined for these sheets at a number of intervals over the visible light range. These data were employed to calculate the specific absorption coefficients for the unbleached sheet according to the Steele modification (*19, 20*) of the original Kubelka-Munk theory (*21*). The specific absorption coefficients for the unbleached handsheet are summarized in Table VII and are represented by K'_{us} and K'_{bs}, respectively.

It is important to note that the specific absorption coefficients for the lignin solutions are expressed in exactly the same units as the specific absorption coefficients for the unbleached handsheet—namely, square centimeters per gram.

DISCUSSION

Chemical Analyses of Groundwood Pulps

The data in Table II clearly demonstrate that, as evaluated in terms of current analytical procedures, the components of groundwood are not appreciably altered by sodium peroxide bleaching.

Table VI. Specific Absorption Coefficients and Absorption Decrements for Isolated Native Lignin[a]

λ m mu	a_u	a_b	Δ_a	$2\Delta_a$
450	250	121	129	258
500	131	62	69	138
550	74	36	38	76
600	43	22	21	42
650	24	13	11	22
700	16	7.5	8.5	17

[a] Units of specific absorption coefficients and absorption decrements are square centimeters per gram.

The lignin component, which is frequently considered a primary source of color in wood, appears to be unaltered in either amount or methoxyl content.

The uronic acid data fail to show any definite trend. It is quite possible that the analytical method was not sufficiently precise to show the effect of sodium peroxide upon this component.

Table VII. Specific Absorption Coefficients and Absorption Decrements for Groundwood Handsheets[a]

λ mmu	K'_{us}	K'_{bs}	$\Delta K'_s$	$\Delta K'/0.267$
450	78.2	58.7	19.5	73.0
500	40.4	23.3	17.1	64.0
550	24.1	13.4	10.7	40.1
600	15.3	9.6	5.7	21.4
650	9.6	6.4	3.2	12.0
700	6.9	4.6	2.3	8.6

[a] Units of specific absorption coefficients and absorption decrements are square centimeters per gram.

The hydrolysis of acetyl groups is brought about by simple alkaline treatment of the pulp. This action appears to be accelerated by the presence of sodium peroxide. It is hardly conceivable, however, that this effect could be related to the bleaching action of peroxide upon the pulp.

The data indicate that sodium peroxide bleaching produces an increase in organic acidity. This increase appears to be significant and is indicative of oxidative attack of the pulp by the sodium peroxide. These data give no evidence, however, regarding which component or components are the subject of such an attack.

Simple alkaline treatment of the groundwood decreased the amount of total ethanol-soluble materials from 1.22 to 1.09%. The amount of this material was further decreased to 0.98% when 2% peroxide was used, and to 0.92% upon the application of 4% peroxide. Furthermore, the peroxide-treated pulps contained a greater amount of hot water-soluble material than the alkali-treated pulp. These data strongly suggest that the sodium peroxide reacted with at least a portion of the ethanol-soluble materials and rendered them soluble in hot water.

An Approximate Sodium Peroxide Consumption Balance

The conditions employed for determining sodium peroxide consumption by the ether- and ethanol-soluble materials in spruce groundwood were undoubtedly more drastic than those which prevail during a normal groundwood bleaching operation. Consequently, the results of these tests cannot be used in a direct calculation of the amount of sodium peroxide that is consumed by these materials under actual groundwood bleaching conditions. An estimation of this quantity can be made, however, through the indirect means described below.

First, it should be noted that, under the same testing conditions, isolated native lignin and the ether- and ethanol-soluble materials in groundwood consume sodium peroxide to somewhat the same extent. Second, the amount of sodium peroxide consumed by extractable native lignin under actual groundwood bleaching conditions can be approximated by comparing curves 2 and 4 in Fig. 3. Curve 2 represents the sodium peroxide consumption by native lignin isolated from unbleached groundwood; curve 4 is the corresponding consumption curve for native lignin isolated from bleached groundwood. The difference between these curves is interpreted as a measure of the amount of sodium peroxide that is consumed by extractable native lignin under the actual conditions of groundwood bleaching—namely, 0.01 gram of sodium peroxide per gram of extractable native lignin.

The ether- and ethanol-soluble materials in spruce groundwood are present to the extent of 0.5 and 1.22%, respectively. Hence, in view of the first observation, an approximate estimation of the total peroxide consumed by these extractives under the actual conditions of groundwood bleaching is $(0.5 + 1.22) \times 0.01 =$ 0.0172 gram of sodium peroxide per 100 grams of pulp. Curve 1, Fig. 7, indicates that, during a typical groundwood bleach with 2% sodium peroxide, the pulp consumes 1.56 grams of sodium peroxide per 100 grams of pulp. Thus, it can be calculated that the ether and ethanol extractives are responsible for approximately 1% of the total peroxide consumption.

It is notable that certain other chemical data suggest that extractable native lignin may consume as much as 4.3% of its weight of sodium peroxide during a groundwood bleaching operation. The reasoning

behind this estimation is quite indirect and far too lengthy to include in this report. Even in such a case, the calculated consumption by extractives would amount to only about 4% of the total peroxide consumed during a normal bleaching operation. Thus, although the data are not sufficient to calculate the exact amount, it seems reasonable to conclude that the ether and ethanol extractives in spruce groundwood are responsible for only a small percentage of the total peroxide consumed during bleaching.

The results of the peroxide consumption tests on methylated groundwood offer an indirect method for determining the relative amounts of sodium peroxide consumed by the total lignin and holocellulose *in situ*. This method is based on the discovery that diazomethane methylation of isolated native lignin essentially blocks the consumption of sodium peroxide by this material.

Brown (*23*) discussed the methylation of wood meal with ether solutions of diazomethane. As a result of an extensive literature survey, he concluded that diazomethane, under strictly anhydrous conditions, methylates only acidic hydroxyl groups and, under such conditions, carbohydrates are not appreciably methylated.

In the case of the present work, then, it is probable that any methylation of the holocellulose took place principally on the uronic acid groups. Since carboxyl groups are not ordinarily subject to oxidative attack, it is probable that the response of the holocellulose fraction to peroxide oxidation was not appreciably altered by methylation of the groundwood.

The following calculations demonstrate that increasing the methoxyl content of the pulp from 4.98 to 7.94% corresponds very closely to complete methylation of the acidic groups in the groundwood.

The original pulp contained 26.7% of Klason lignin, which had a methoxyl content of 16.15%. It can be calculated that the methylation of the enolic and phenolic hydroxyl groups in the lignin would increase the methoxyl content of the lignin to 23.3%. Thus, the percentage increase in the pulp methoxyl resulting from the methylation of the lignin would be $(23.3 - 16.15) \times 0.267 = 1.91\%$.

It is not possible to calculate the exact percentage of carboxyl groups in the holocellulose that are capable of methylation. A minimum value is the known free carboxyl groups—namely, the organic acidity, which is 0.37%. A maximum value is the sum of the organic acidity and the uronic acids, or 1.56%. On this basis, it can be calculated that from 0.28 to 1.17% of methoxyl is introduced into the pulp by methylation of the carboxyl groups in the holocellulose.

The calculation is completed by making the following summation:

	%
Original groundwood methoxyl	4.98
Methoxyl introduced into the lignin	1.91
Methoxyl introduced into the carboxyl group	0.28 — 1.17
Calculated methoxyl	7.17 — 8.06
Experimental methoxyl	7.94

Methylation of the lignin was further indicated by a typical brightening of the pulp and by the failure of the methylated pulp to give a positive lignin test with phloroglucinol and hydrochloric acid.

The results of the experiments on the methylated derivatives of isolated native lignin suggest that complete methylation of the total lignin with diazomethane would essentially block any reaction between the latter groundwood component and sodium peroxide. Furthermore, Brown's conclusions indicate that methylation of the groundwood would leave the holocellulose component virtually unaltered with respect to its reactivity toward sodium peroxide. Therefore, curve 2 in Fig. 6, the peroxide consumption curve for methylated groundwood, probably represents a reasonable estimate of the peroxide consumption by holocellulose *in situ*. Also, the difference between the peroxide consumption curves for the unmethylated and methylated groundwood (Fig. 6, curves 1 and 2) presumably represents an estimate of the consumption of sodium peroxide by at least a portion of the extractives and by the total lignin *in situ*.

An attempt was made to determine the capacity of holocellulose to consume sodium peroxide by testing the isolated material. Curves 3 and 4 (Fig. 6) undoubtedly are not a good measure of this quantity because the holocellulose contained residual lignin that could not be removed without seriously modifying the holocellulose. The methylation technique was employed to inactivate this residual lignin. Curves 5 and 6 (Fig. 6), indicate that isolated holocellulose has a somewhat greater capacity than holocellulose *in situ* to consume sodium peroxide. One possible explanation for this difference might be that the separation of lignin from holocellulose exposes an appreciable quantity of the latter to peroxidic attack.

Of the two methods used for estimating the capacity of holocellulose (and the total lignin by difference) to consume sodium peroxide, the former is probably the better since it is not complicated by the uncertainties associated with the properties of isolated holocellulose.

For purposes of convenience, the foregoing study was carried out at very low consistencies. Hence, the results do not apply strictly to a typical groundwood bleach at 5% consistency. In order to make an estimate of the sodium peroxide consumption by holocellulose and lignin under typical bleaching conditions, peroxide consumption tests were carried out on methylated and unmethylated groundwood at 5% consistency. In view of the preceding discussion, the data in Fig. 7 suggest that, during a low-density groundwood bleaching operation, the holocellulose portion of the pulp is responsible for about 60% and the lignin for about 40% of the total sodium peroxide consumed.

As demonstrated at the beginning of this discussion, the extractives appear to play a relatively minor role from the standpoint of peroxide consumption, being accountable for only 1 to 4% of the total peroxide consumed.

Reaction Between Sodium Peroxide and Extractable Native Lignin

The peroxide consumption data for isolated native

lignin (Fig. 3) suggest that two different reactions take place between sodium peroxide and isolated native lignin. One reaction appears to proceed initially at a rapid velocity and apparently runs to completion after two hours. The amount of sodium peroxide consumed by this reaction is approximately proportional to the lignin concentration. The other reaction (straight line portion of the curves) seems to progress at a very slow rate that is fairly constant and essentially independent of the lignin concentration.

When sodium peroxide reacts with isolated native lignin, it renders a portion of the lignin soluble in dilute mineral acid. Fractions B and C (Table III) are examples of this solubilized lignin. These fractions are much lower in methoxyl, carbon, and hydrogen than the original isolated native lignin and, presumably, are the result of oxidative attack by the peroxide. The yield data in Table IV suggest that these products are formed primarily during the initial rapid reaction between the lignin and peroxide. The bleaching action of the peroxide also appears to take place primarily during the rapid reaction, since the lignin that was bleached for six hours was of essentially the same color as the lignin that was bleached for two hours (through the initial rapid reaction only). It will be recalled that both products were lighter in color than the original lignin.

At this point, it is interesting to note that the similarity between the chemical analyses of fraction C and the ligninlike material which was obtained from waste peroxide bleach liquor (Table III). This similarity suggests that the latter is a product of the lignin-peroxide reaction.

In general, the chemical analyses of the fraction A-type products (Tables III and IV) are very similar to the analysis of the original native lignin. The analysis of the fraction A product isolated from the two-hour bleach differs from that of the original lignin by an amount that is within the limits of experimental error. The chemical similarity between the original and the bleached (two hour) lignins was further tested by preparing the methanol derivative of each of these materials according to the method of Brauns (*15*). The two derivatives were found to have identical methoxyl contents. The chemical similarity between the bleached and unbleached lignins is quite surprising when it is noted that the bleached lignins resulted from a reaction between the original lignin and at least 10% of its weight of sodium peroxide.

In view of the above considerations, it appears that the initial rapid reaction between sodium peroxide and isolated native lignin involves a material portion of the lignin rather than some specific group in the lignin. Presumably, a portion of the extractable native lignin (about 30%) is quite sensitive to attack by sodium peroxide and, even under mild conditions of temperature and peroxide concentration, is oxidized into highly modified, acid-soluble fractions. The remaining portion of the lignin, perhaps through some slight difference in chemical structure, appears to be relatively stable toward sodium peroxide. The data in Fig. 4 illustrate the high resistance of this inert fraction toward peroxidic attack.

Evidence that a reaction between the peroxide and extractable native lignin does take place during actual groundwood bleaching is found in the fact that the lignin extracted from bleached groundwood does not have as great a capacity to consume sodium peroxide as the lignin extracted from unbleached groundwood (curves 2 and 4, Fig. 3). It was pointed out previously that these data indicate the consumption of 0.01 gram of sodium peroxide by each gram of extractable native lignin *in situ*.

Quantitative evidence that extractable native lignin is bleached under the actual conditions of groundwood bleaching is offered by the optical data in Table VI. Throughout the entire visible range of light, the specific absorption coefficients of the unbleached lignin are approximately twice the corresponding coefficients for the bleached lignin.

The results of the experiments on certain methylated derivatives of isolated native lignin are of value in determining the possible nature of the peroxide-sensitive portions of the lignin. Since methylation of the carbonyl groups decreased the total peroxide consumption by the lignin to 38% of the original value (curve 3, Fig. 5), it is quite evident that at least a portion of these groups is in some way involved in the lignin-peroxide reaction.

When approximately 50% of the carbonyl groups and 50% of the phenolic hydroxyl groups were protected by diazomethane methylation, the peroxide consumption of the lignin was decreased to approximately 36% of the original value (curve 4, Fig. 5). If only the carbonyl groups, and not the phenolic hydroxyl groups, were involved in the lignin-peroxide reaction, it would be expected that the above methylation would decrease the peroxide consumption of the lignin to approximately 70% of the original value (calculated on the basis of the peroxide consumption by derivative II). The fact that this methylation resulted in a decrease in the total peroxide consumption to, not 70 but 36% of the original value is evidence that partial methylation of the phenolic hydroxyl group had some effect upon the chemical reactivity of the lignin toward sodium peroxide.

Further evidence that both the phenolic hydroxyl groups and the carbonyl groups are involved in the lignin-peroxide reaction is found in the fact that derivative I consumed only 12% as much peroxide as the original lignin (curve 2, Fig. 5). It will be recalled that this derivative was almost fully methylated with respect to both the phenolic and enolic hydroxyl groups and, hence, was insoluble in sodium peroxide bleach liquor. Consequently, it was necessary to test this derivative in suspension rather than in solution. The possibility exists, therefore, that the high resistance of this derivative toward peroxidic attack may have been, at least in part, a result of its physical form. This possibility does not exist in the case of derivatives II and III, because they were tested in solution.

Thus, the data obtained in the present work provide strong evidence that at least a portion of the phenolic hydroxyls and the carbonyl groups in extractable native lignin are largely responsible for the capacity of this groundwood component to react with sodium peroxide. The data are not sufficient to show whether

these two groups react in conjunction with, or independent of, one another.

Reaction Between Sodium Peroxide and the Total Lignin in Groundwood

The experiments performed on methylated derivatives of isolated native lignin and on methylated groundwood have resulted in chemical evidence that, during a normal groundwood bleaching operation, extractable native lignin and the total lignin probably react with sodium peroxide in essentially the same manner.

An attempt has been made to incorporate the optical data (Tables VI and VII) in certain calculations, the purpose of which was to demonstrate quantitatively that sodium peroxide exerts a similar bleaching effect upon extractable native lignin and the total lignin in spruce groundwood. Such a calculation did not prove feasible, however, for a number of reasons, the most disturbing of which is that the lignin and other constituents of wood tissue do not occur in completely homogeneous admixture. The significance of this situation should become more apparent in the ensuing discussion.

Nevertheless, the optical data do appear amenable to a type of treatment which suggests, at least qualitatively, that the extractable native lignin and the total lignin in groundwood are bleached in a similar fashion. This qualitative treatment of the data will be discussed presently, but first it is important to mention two concepts that have been pointed out recently by Van den Akker (*22*).

Van den Akker has shown that, in the general case, the value of a specific absorption coefficient measured by means of diffuse illumination is exactly twice the value obtained through parallel ray illumination. In the present work, the specific absorption coefficients of groundwood handsheets (K'_{us} and K'_{bs}) were calculated from measurements conducted under conditions of diffuse illumination, whereas the specific absorption coefficients of isolated native lignins (a_u and a_b) were obtained through parallel ray measurements. Accordingly, the K' values and the a values can be discussed on a comparable basis only if the latter are multiplied by a factor of two.

Van den Akker also suggested that the value obtained for the specific absorption coefficient of a material depends upon the homogeneity of distribution of that material in its supporting medium. This principle has direct application to the present work since the distribution of lignin in groundwood probably is not entirely homogeneous. Hence, it seems advisable to correct the calculated specific absorption coefficients of the total lignin by a distribution factor, f.

The quantity f is dimensionless and would have a value of unity if the lignin were homogeneously distributed. For any degree of nonhomogeneous distribution, f assumes some value less than unity.

Returning now to the qualitative treatment of the optical data, it is well to mention first that the effect of bleaching a material ordinarily is to decrease its capacity to absorb light either in some range of the visible spectrum or, as is the case with peroxide bleaching of spruce groundwood, at all wavelengths over the visible range. For the purpose of the present analysis of the optical data, therefore, the bleaching effect of sodium peroxide upon a given material is evaluated in terms of the decrease which the peroxide brings about in the specific absorption coefficients of that material. Such a decrease in the specific absorption coefficient at a given wavelength of light will be termed the "absorption decrement." Mathematically, this quantity is represented by the numerical difference between the specific absorption coefficients of the bleached and unbleached materials. Therefore, its units are square centimeters per gram. Absorption decrement is generally found to be a variable function of wavelength.

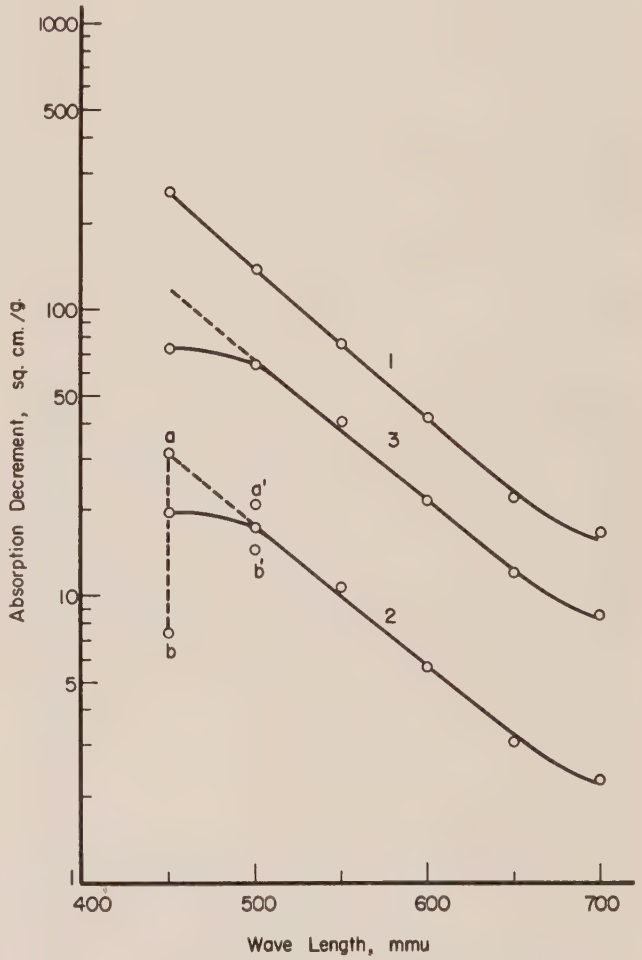

Fig. 8. Absorption decrements of isolated native lignin and groundwood handsheets

(1) 2 Δa *vs.* mmu. (2) (F) $(\Delta K'_s)$ *vs.* mmu; $F = 1$. (3) (F) $(\Delta K'_s)/0.267$ *vs.* mmu; $F = 1$.

The fundamental relationship between chemical structure and absorption spectra leads to the basic premise of the present qualitative treatment of the optical data—namely, that it is reasonable to expect an equally fundamental relationship to exist between a given change in the absorption spectrum of a material and the chemical reactions which serve to bring about the change. In the case of the present analysis, the curve representing logarithm of absorption decrement vs. wavelength of incident light is interpreted

as a measure of the change in the absorption spectrum that is brought about by bleaching. The semilogarithmic system of plotting the data is employed to facilitate a comparison of the several curves. When such a system is used, two curves, the ordinates of which are related to one another through a constant factor, will be separated by a constant linear distance.

Curve 1, Fig. 8, is a semilogarithmic plot of $2\Delta a$ (twice the absorption decrements of isolated native lignin) vs. wavelength of incident light. This represents, of course, the same curve that would be obtained had the individual specific absorption coefficients been measured by diffuse rather than by parallel light illumination and then plotted directly (without multiplying by two). Curve 2 represents a semilogarithmic plot of K'_s (absorption decrements of the groundwood handsheet) vs. wavelength of incident light. It will be noted that these curves are virtually identical in form with the exception of the 450 to 500 mmu range. The question immediately arises as to whether this discrepancy is real or whether, on the other hand, it might be the result of experimental error. As will be demonstrated below, the latter situation is highly possible.

The positioning of the absorption decrement for the isolated native lignin at 450 mmu and, in fact at all wavelengths, is undoubtedly accurate since each individual specific absorption coefficient was obtained by averaging three rather precise measurements. However, there exists a high probability of error in the location of the 450 mmu absorption decrement for the groundwood handsheet. Points a and b embrace the calculated range of values for this absorption decrement if it is assumed that the reflectance measurements (from which such a decrement is calculated) were accurate to ± 0.2 reflectance units.* Since such an error in the reflectance measurements is possible, it is concluded that the discrepancy at 450 mmu may not be real. Thus, it is entirely possible that further measurements might demonstrate the two curves in question to be of similar form over the entire visible range. In such a case, the only notable discrepancy would be in the relative displacement of the curves on the vertical axis.

Curve 3, Fig. 8, represents the plot that is obtained when the absorption decrements of the handsheets are calculated on the basis of the lignin in the sheet.† It will be noted that this curve lies fairly close to curve 1, but is still displaced from the latter by a factor of approximately two.

In terms of the concepts previously discussed, curve 3 might be interpreted to represent a plot of the absorption decrements of the total lignin in the groundwood, such lignin being assumed to have a distribution factor of unity. For any degree of nonhomogeneous distribution of the lignin, the distribution factor would be less than unity, and the two curves in question would lie even closer together. Furthermore, certain chemical data (not discussed in this report) suggest that the total lignin may consume only 85% as much sodium peroxide as the extractable native lignin. In such a case, a slight vertical displacement of curves 1 and 3 would be understandable.

* Points a' and b' represent the corresponding range at 500 mmu. Note that the probability of experimental error is greatly diminished at the longer wavelengths.

† Obtained by dividing each absorption decrement by 0.267, the fractional content of Klason lignin in the groundwood.

CONCLUSION

In conclusion, the optical data exhibit two important features. First, it appears quite possible that, if more accurate data were available, the absorption decrement function of extractable native lignin might have the same general form as the absorption decrement function of the groundwood itself. Secondly, when based on the lignin content of the groundwood, the absorption decrement function of the groundwood is of the same order of magnitude as the corresponding function for isolated native lignin. Furthermore, there is a definite indication that the displacement of these two functions may be largely attributable to the manner in which lignin is distributed in the wood tissue. In view of the basic premise previously mentioned, these observations are interpreted as qualitative evidence that sodium peroxide bleaches the total lignin in groundwood as well as the extractable native lignin, and that these two manifestations of lignin probably react with sodium peroxide in a similar fashion.

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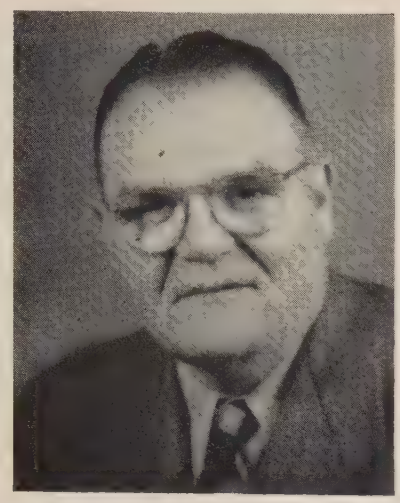

A. E. Bachmann

The year of 1949 for TAPPI was essentially a year of consolidation of past advances rather than a year of extensive changes.

The magazine *Tappi* ended its initial year of publication with universally good acceptance from all members with regard to its format and scientific contents. It has also been established on a financially successful basis. The consummation of this project into a successful finished job was largely the work of your Secretary, R. G. Macdonald. His infinite capacity for hard work and rapid mastery of detail in the publishing field did much to produce the fine result obtained. This is repetition of the remarks I made concerning this subject at the Pacific Coast meeting, but it is deliberately done in an effort to emphasize his prodigious accomplishment.

The Editorial Board, under the leadership of C. J. West, has admirably upheld the scientific integrity of the articles published in the magazine and through its efforts has done much to improve the caliber of the papers, one of the fundamental ideas behind the decision to publish the magazine.

In order to concentrate on the Pacific Coast meeting, only four meetings, aside from the annual meeting, were held this year. In April, the Coating Conference, sponsored by the Coating Committee and the Kalamazoo Valley Section, was held in Grand Rapids, Mich. This meeting drew a large, nationally distributed attendance and gained many very favorable comments for the quality of its program and interesting mill visits to the coating plants in and near Kalamazoo.

In September an old style general fall meeting was held at Portland, Ore. under the sponsorship of our Pacific Section. As the result of eighteen months of the most intensive preparation on the part of many committees under the leadership of general co-chairmen A. G. Natwick and R. J. LeRoux and program chairman and chairman of the Pacific Section W. F. Holzer, a truly remarkable meeting was held. The woods trip, mill visits, entertainment, technical program, and luncheon speakers were unsurpassed. In the eyes of many blase convention goers of long standing the series of high lights produced there surpassed any general TAPPI fall meeting of the past.

In October the Fourth Engineering Conference of the Pulp and Paper Industry was held in Boston under the sponsorship of the Engineering Division and a local committee headed by M. Jacobs. George H. Pringle, General Chairman, and J. W. Hemphill, Secretary, arranged an exceptionally fine technical program. This meeting was described by many as the best Engineering Conference to date.

In November a meeting of the Fibrous Agricultural Residues Committee was held at Terre Haute, Ind. under the sponsorship of the Terre Haute Paper Co., and the chairmanship of S. I. Aronovsky.

While the meetings this year were few in number, they were all exceptionally high in quality of programs, mill visits, and special features.

Committees

Our active committees have produced their usual fine volume of scientific papers bringing out the latest developments in their respective fields. The work of some of them was exceptionally noteworthy and should be singled out for individual attention. Among these the work of the Coating Committee over a period of years under the direction of Werner Kaufmann has culminated in the production of a series of monographs and the merit-worthy coating convention held last year in Grand Rapids.

The Engineering Division under the direction of George H. Pringle and the chairmen of the respective committees produced many important and interesting papers in connection with the Fourth Engineering Conference. This Division has produced from within its ranks high grade and active leadership for its committees. The devotion to purpose of this group deserves our highest commendation.

Another very active committee over many years, which annually holds its own conference in the Middle West, is the Fibrous Agricultural Residues Committee, under the leadership of S. I. Aronovsky. Its meeting held at Terre Haute in November brought out a representative attendance from the strawboard industry.

Sections

The work of all our local sections continues to improve constantly with respect to the development of attractive technical programs and a consequent greater attendance at meetings. The sections have also done much to develop responsible leadership among the younger members whose assiduous efforts have produced fine results in practically all our sections.

We note with pleasure that some of the sections are sending into National headquarters more and more detailed accounts of their meetings with discussions and papers to be printed in *Tappi*. This we feel will result in the greater dissemination of much valuable material, formerly not available.

Future Plans

During the past year the Executive Committee has worked to lay the groundwork for some of the next series of advances that loom before us as essential parts of our future program.

Your Publications Management Committee, under the able leadership of Vice-President K. P. Geohegan, has held several meetings this year to determine a detailed publications policy, not only pertaining to the relationship of all TAPPI publications to other industry publications but also to coordinate the intra-TAPPI policy with respect to the rela-

tionship among the various TAPPI publications such as *Tappi*, the monographs, TAPPI sponsored books, TAPPI Data Sheets, Standards, etc. It has made considerable progress to date but there still remains considerable work to be done before all the policies can be completely formulated.

One of the prime objectives of TAPPI for the future is definitely to organize various parts of the existing literature into more readily accessible forms for reference purposes. Provision is already being made for a considerable expansion of the data sheet activities by various committees, eventually to lead to an engineering handbook on paper technology. During the year we have proposed the idea and delineated in detail a technique for expanding the organization of the Paper Manufacturing Committees in order to get down to smaller groups possessing common problems. It is hoped that such groups will be able to make a more concerted attack on the various parts of the subject of papermaking principles and to start us on the road to producing a science of paper technology. To this end we expect to produce shortly an illustrative example of the results of such a technique.

The Routine Control Methods, which were gathered through the cooperation of our sections are now at the printer and will be available soon. We expect that their revision and augmentation will provide much of practical value for some of our committees to work on during the coming year.

We expect to start the organization of a Cost Engineering Committe this year to work out standard definitions and methods of calculation for various operating efficiency ratios and, to attempt, in some fields, where sufficient interest exists, to get inter-mill comparisons for purposes of establishing better operating standards, together with examination of methods for producing them.

Membership Obligations

TAPPI, this year, has again increased considerably in membership. It now has over 4200 members. This membership includes administrative executive, production managers, superintendents, engineers, chemists, and other technically trained men. Among others, it also includes a broad range of occupations from the allied industries. This large and variegated membership is a tribute to the accomplishments of TAPPI in the past. It is also, at least partly, due to an expectancy for continued accomplishment in the future.

To properly serve such a large and constantly growing membership it is essential that TAPPI continue not only to progress along established lines of endeavor but also that it expand and diversify its activities to produce meetings and material for a wider range of interests. Your Executive Committee, technical committee members, and local section committees have constantly attempted to initiate new projects and give them initial impetus in an effort to meet this need These committee members are busy people who give freely of their time and research knowledge to improve the status of TAPPI in the interests of the members and their companies.

In order to maintain the continued progress of TAPPI it is also vitally necessary that a greater proportion of the TAPPI membership individually take part in its programs and activities. Membership in TAPPI implies a responsibility on the part of its entire membership to take an active part in some phase of its activities so that all can benefit from the work and experience of each other.

Some of the specific benefits available to the members and their mills by attendance at TAPPI meetings and active participation in its programs are in many cases very practical. They derive from these activities many new ideas concerning equipment, process, and control methods, which they can investigate for a practical feasibility of incorporating with value into their own procedures. They receive corroboration of their own ideas, independently arrived at by others with similar problems, to confirm their own judgments on impending decisions on complex equipment process and research problems. The mutual exchange of experiences arising from time consuming effort and often considerable expense applied to differing problems, save time and cost for all participants. Exchange of mutual experiences also often brings to light some of the equipment and raw material rigidities which often preclude the completely successful solution of their specific problems in individual mills.

The everyday work of the TAPPI membership embraces practically all the sciences, such as chemistry, physics, biology, as well as mechanical, electrical, civil, and cost engineering and paper technology. To a considerable extent the daily work of all of us calls for varying degrees of specialization or semispecialization in one or more of these fields, but it involves also a knowledge of many related sciences or phases of other sciences. As a result it is necessary for all of us to acquire a relatively broad background in many related fields. Helping each other by cooperatively working together on TAPPI committees creates a literature which enables us to get abreast of the essentials of a related phase of science or paper technology. It is here that TAPPI has one of its principal functions.

To produce these benefits to the greatest degree most effectively TAPPI needs very much more active participation of more of its members in its various committee activities.

In late years research and engineering staffs and facilities have been considerably expanded in order to create new products, to increase production, and to develop better methods of operation resulting in improvement in quality of our existing products. Great emphasis has also been laid on the necessity for continuous cost reduction in all its phases to minimize wastes of materials, steam, heat, power, and manhours. This entire improvement function demands that we all do many more things better, and it is a logical function for TAPPI members to work at them in their various organizational capacities. Management looks largely to its TAPPI members to perform various phases of the improvement function. TAPPI as an organization accepts this responsibility and hopes that the caliber of its work will continue to merit the support of our industry management to the extent that they will encourage their men to take a more active part in TAPPI activities as an essential part of their educational training.

ALBERT E. BACHMANN, *President* TAPPI

Report of the Secretary

During 1949 the Technical Association of the Pulp and Paper Industry experienced considerable growth in membership and was a very productive year with respect to meetings held, divisional and local section activities. Of outstanding interest was the Association's new monthly magazine which completed its first year.

Membership

There were 565 individual members elected in 1949, 213 members resigned or were dropped. On Dec. 31, 1949, the total individual membership was 4015.

There were 22 corporate and 23 sustaining members elected. Three corporate and 3 sustaining members resigned. The corporate membership on Dec. 31, 1949 was 209, and the sustaining membership was 193.

The following companies became corporate members in 1949:

A. Ahlstrom O/Y, Warkaus, Finland
Aktieselskapet Borregaard, Sarpsborg, Norway
S. A. Cartiere Giacomo Bosso, Torino, Italy
Brownville Paper Co., Brownville, N. Y.
Columbia Boxboard Mills, Inc., Chatham, N. Y.
Crane & Co. Inc., Dalton, Mass.
Direccion General de Suministros del Estado, Buenos Aires, Argentina

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of the Bird Machinery that is designed, constructed and applied to help *you* make *better pulp and paper and more of it per day at lower cost per ton.*

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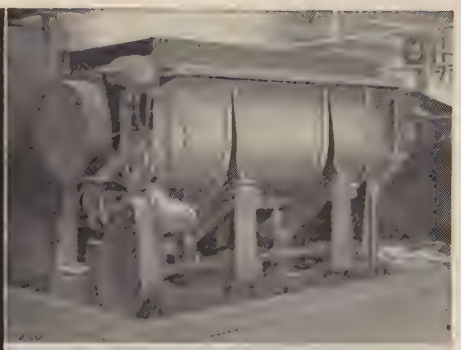
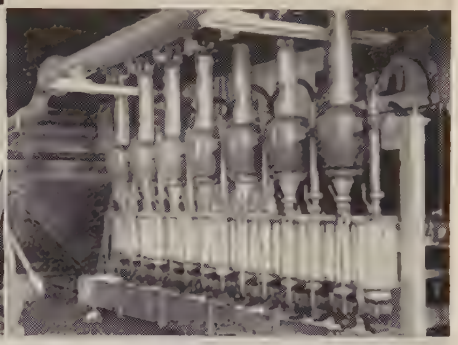
For bulletins, recommendations, layouts and estimates get in touch with BIRD.

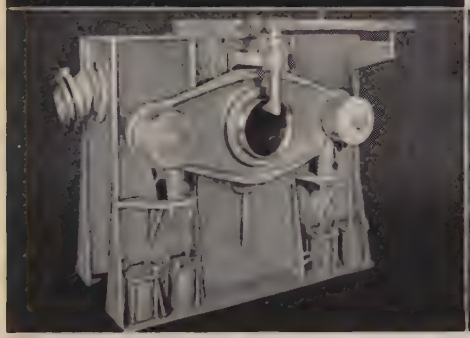


BIRD SCREENS — essential for continuous, maximum output of uniformly good paper. Ninety million pounds of paper pass through Bird Screens every day.

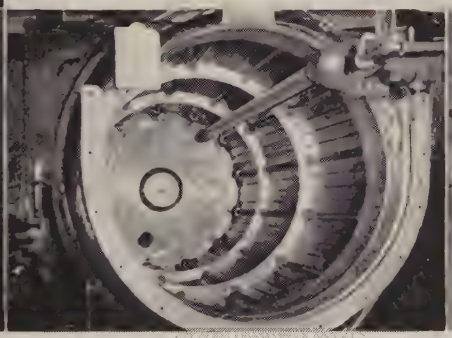
BIRD JONSSON SCREENS — handle big volumes of high consistency stocks with minimum fibre loss. The ideal knotter (perforate plates) and fine screen (slotted plates).



DIRTECS — for thorough, efficient removal of heavy and fine dirt both ahead of Bird Screens and as screen tailings units.

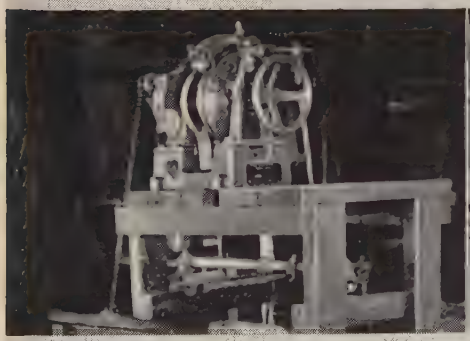


BIRD VIBROTOR SCREENS — for quality screening of bleached or unbleached pulp. Handles 50 tons per day through .012" plates at 1.3 to 1.5% consistency.



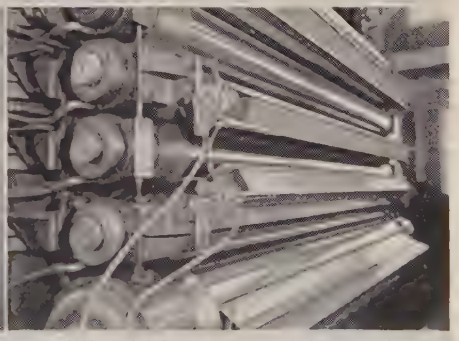
SHOWER PIPES — both Self-Cleaning and Oscillating. The Bird Oscillating Shower, pictured, increases screening efficiency, uses far less water.

BIRD SAVE-ALLS — for low cost recovery of good fibres from machine waste water. Quickly pays for itself out of net savings in stock, water and time.



BIRD CONSISTENCY REGULATORS — for holding stock consistency to not more than 0.1% heavier or lighter than desired. Dependable, economical, trouble-free.

VICKERY FELT CONDITIONERS — for keeping press felts continuously clean and absorbent without mid-week shutdowns. Improve paper finish, speed drying, save steam.



VICKERY DOCTORS — carefully engineered for application to each individual press roll, wire roll, dryer, calender and super-calender roll.

BIRD MACHINE COMPANY

SOUTH WALPOLE • MASSACHUSETTS

A/S Follum Fabrikker, Hoenefoss, Norway
N. V. Papierfabriek "Gelderland," Nymegen, Holland
General Waxed Papers, Inc., Chicago, Ill.
Gujarat Paper Mills Ltd., Barajado, India
Hollingsworth & Vose, East Walpole, Mass.
Honshu Paper Mfg. Co., Ltd., Tokyo, Japan
Jugo Paper Mfg. Co. Ltd., Tokyo, Japan
Kokusaku Pulp Co., Asahikawa, Hokkaido, Japan
Cartiere F. A. Marsoni, Venezia, Italy
Mosinee Paper Mills Co., Mosinee, Wis.
National Development Co., Pulp & Paper Mill Dept., Manila, P. I.
Netherlands Experiment Station for the Utilization of Straw, Groningen, The Netherlands
Shree Gopal Paper Mills Ltd., Abdullapur, India
South Africa Forest Investments Ltd., Johannesburg, S. A.
Hugh Stevenson & Sons Ltd., London, England

The following companies became sustaining members in 1949:

Atlas Mineral Products Co., The, Mertztown, Pa.
California Research Corp., San Francisco, Calif.
Chain Belt Co., Milwaukee, Wis.
Chiksan Co., Brea, Calif.
W. A. Cleary Corp., New Brunswick, N. J.
Curlator Corp., Rochester, N. Y.
Frank W. Egan & Co., Bound Brook, N. J.
Ethyl Corp., New York, N. Y.
Fischer & Porter, Hatboro, Pa.
Holyoke Machine Co., Holyoke, Mass.
J. M. Huber Corp., New York, N. Y.
Morden Machines Co., Portland, Ore.
Myers, Fuller & Addington, New York, N. Y.
National Aluminate Corp., Chicago, Ill.
National Starch Products, Inc., New York, N. Y.
Niagara Alkali Co., New York, N. Y.
Paper Mill News, New York, N. Y.
Perkins-Goodwin Co., New York, N. Y.
Sinclair Co., The, Holyoke, Mass.
Sindar Corp., New York, N. Y.
Smith & Winchester Mfg. Co., South Windham, Conn.
Tracerlab, Inc., Boston, Mass.
Union Screen Plate Co. of Canada Ltd., Lennoxville, P. Q., Canada

Necrology

The Association lost through death the following members:

Robert Bell-Irving, Powell River Co., Ltd.
Sven B. Bugge, Tomahawk Kraft Paper Co.
Richard Feibelmann, The Aktivin Corp.
Royal V. Heath, Jr., The Heath Co.
Edward J. Johnstone, Lockport Felt Co.
C. H. L. Jones, Price Bros. Co. Ltd.
Richard D. Kehoe, Paper and Industrial Appliances
Ernest J. Kirkup, Donside Paper Co. Ltd.
Herman L. Kutter, Black-Clawson Co.
A. I. Macnaughton, Ellengowan Paper Co. Ltd.
William G. MacNaughton, Newsprint Service Bureau
Henry P. Madsen, Appleton Machine Co.
Lewis B. Miller, University of Cincinnati
John C. Monty, Canadian International Paper Co.
J. Brooke Shaughnessy, American Wringer Co.
Erik Solitander, The Finnish Board Mills Assn.
Sanford E. Thompson, Thompson & Lichtner Co.
Howard L. Vincent, George Vincent, Inc.
Charles G. Weber, National Bureau of Standards
Edward A. Weber, Oregon Pulp & Paper Co.
Pete Wright, The Bagley & Sewall Co.

Spring and Fall Meetings

Prior to World War II it was customary for the Association to hold two national meetings each year, the annual meeting during Paper Week in February and a general fall meeting. The last general fall meeting was held in Chicago in 1943 and was devoted to the packaging needs of the Army, Navy, and Air Forces. Because of hotel and transportation problems it was not possible to hold the customary large fall meetings in the years following 1943.

As a result of this a new form of meeting was developed, namely one devoted intensively to a limited scope. Instead of a single general fall meeting there have been a number of functional meetings held since the war ended.

Although these functional meetings have generally been held in the fall, one such meeting was held in the spring of 1949.

The Coating Conference

The first of the functional meetings was held at the Pantlind Hotel, Grand Rapids, Mich., on April 26–27, 1949. The meeting was sponsored by the TAPPI Coating Committee, Werner Kaufmann, Kupfer Bros. Paper Co., Chairman and the Kalamazoo Valley Section, P. W. Bartholomew, Hawthorne Paper Co., Chairman, W. A. Kirkpatrick of the Allied Paper Mills, Kalamazoo, Mich., was General Chairman of the Conference. Prior to 1949 all Coating Committee sessions were held in New York. It is possible that in the future these conferences will alternate annually between the February meeting in New York one year and a meeting held the following year in a paper coating center.

General Fall Meeting at Portland, Ore.

Previous general fall meetings were held at Pacific Coast locations in 1934 and 1940. In 1949 the Pacific Section sponsored a general fall meeting which was held at the Multnomah Hotel in Portland, Ore., on Sept. 11–15, 1949. This was one of the best organized conventions ever held by the Association. More than 700 attended, including about 250 from eastern points. A special train of the Union Pacific Railway carried about 125 from New York and Chicago to Portland. Featured at this meeting was a visit to the woodlands of the Weyerhaeuser Timber Co., and visits to a number of the pulp and paper mills located near Portland, Ore. R. J. Le Roux of the Weyerhaeuser Timber Co., and A. G. Natwick of the Crown Zellerbach Corp., were co-Chairmen of the meeting. W. F. Holzer of the Crown Zellerback Corp. was Program Chairman.

Fourth Engineering Conference

Following the unusually successful engineering conferences held at Milwaukee, Philadelphia, and Buffalo, the Fourth Engineering Conference of the Pulp and Paper Industry, sponsored by the Engineering Division was held at the Statler Hotel, Boston, Mass. George H. Pringle, Chief Engineer of the Mead Corp., Chillicothe, Ohio, was General Chairman. About 500 engineers attended. Milton Jacobs of Chas. T. Main, Inc., was Chairman of the Local Arrangements Committee. In addition to an exceptionally fine technical program sponsored by the chairmen of the committees of the Engineering Division the meeting was featured by a banquet tendered by a large number of the machinery plants of New England and by mill visits to the plants of Bird Machine Co., Draper Bros. Co., Foxboro Co., General Electric Co., Norton Co., Lodding Engineering Co., Riley Stoker Co., Rice Barton Corp., and to Bird & Son, Inc.

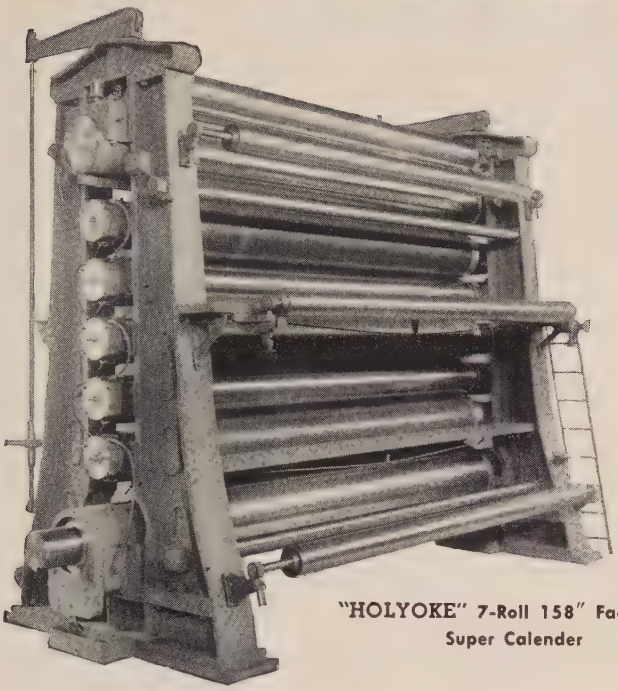
Fibrous Agricultural Residues Conference

Terre Haute, Ind., was the location of the 1949 Conference sponsored by the Fibrous Agricultural Residues Committee. This unusual and very effective committee operates very much like a complete association within the organization. Its meetings, which are devoted to the advancement of the straw pulp and paper industry are attended by individuals representing all manufacturing phases of their respective companies. At the meeting held at the Terre Haute House, Terre Haute, Ind., on Nov. 7–8, 1949, S. I. Aronovsky of the Northern Regional Research Laboratory, Peoria, Ill., was Program Chairman. R. F. Burns of the Terre Haute Paper Co., was in charge of local arrangements. The Terre Haute Paper Co. was host to the Conference and tendered a dinner to the 125 that attended. A visit to the mill of the Terre Haute Paper Co., and to other local industrial plants featured the meeting.

Publications

A major change in publication practice was initiated in

"HOLYOKE"



"HOLYOKE" 7-Roll 158" Face Web Super Calender

HOLYOKE MACHINE COMPANY
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86 YEARS of LEADERSHIP with DISTINCTION

The HOLYOKE MACHINE COMPANY is the oldest manufacturer of Pulp and Paper Mill Machinery in Holyoke, — the Paper City.

"HOLYOKE" design, engineering, manufacturing, and service are backed by 86 years of world-wide experience. Take your problems to "HOLYOKE", — whether you are interested in new machinery or in modernizing your present equipment.

Super Calenders
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DESIGNERS AND BUILDERS OF PAPER, PULP, AND TEXTILE MACHINERY

1949. Beginning in January the Association published a monthly technical magazine. Prior to 1949 and since 1921 many of the Association's meeting papers were published in the Paper Trade Journal and an annual volume of these and other papers appeared in a large cloth-bound volume called technical association papers.

Tappi

Following this long and harmonious relation with the Lockwood Trade Journal Co. the Executive Committee voted to launch an independent magazine to handle the expanding publication material and to conform to the high publication standards of other scientific and engineering societies. During 1949 twelve monthly issues were sent to our members.

In *Tappi* every effort has been made to produce a quality publication. It is printed by the largest and leading printer of technical magazines, the Mack Printing Co., of Easton, Pa., on high-quality machine coated paper. High quality standards have been maintained in the technical articles which have passed the scrutiny of a conscientious Editorial Board, under the chairmanship of Clarence J. West, Institute of Paper Chemistry, Appleton, Wis. Although the meetings and activities of the Technical Association constitute a considerable part of the news of the industry, *Tappi* is not a news magazine but rather a professional journal devoted everlastingly to the advancement of manufacturing techniques through the application of technical and scientific procedures. Its success in accomplishing this during the past twelve months has been reflected in membership growth and the stimulation of committees, local sections, and technical writers.

Bibliography of Paper Making

Continuing its practice of recording the technical literature relating to pulp and paper manufacture since 1900 the Association issued another Bibliography of Paper Making covering 1948. This was prepared by Clarence J. West, Chairman of the Bibliography Committee.

TAPPI Standards

The diligent work of the committees of the Testing Division resulted in the preparation and publication of two new official standards. Six tentative standards were approved and published and several tentative standards were recommended for advancement to official standard status. The manual of Standards now contain 184 standards, of which 167 are testing methods. When it is realized that several years are required for the development of many of these standards the total number adopted represents a great amount of effort on the part of a large number of individuals.

TAPPI Data Sheets

A number of new TAPPI Data Sheets were mailed to our members early in 1949. The Engineering Division, appreciating the value of these publications to those engaged in engineering activities has established a Data Sheet Committee for the purpose of preparing many more interesting and valuable sheets and to improve their general quality.

Monographs

No new monographs were issued but three monographs relating to the paper coating process have been completed and are being edited preparatory to publication.

Routine Control Methods

After a long period of editing and rewriting, a large number of so-called Routine Control Methods are now in process of being printed by the photo-offset method and should be ready for early distribution. These methods are being printed on paper prepared for a 3-ring or 7-ring binder. Every effort has been made to have them be quite different in appearance to the TAPPI Standards. They should not be considered to be in the same category as the Standards but they are methods that have been found to be useful for routine evaluation of paper and pulp mill products and should be of considerable value for estimating certain properties of immediate importance.

TAPPI Medal Award

The 1949 TAPPI Medal was awarded to Hardy S. Ferguson of New York City, well known in the industry because of the large number of pulp and paper mills designed and built by him over a long span of years.

TAPPI Fibrary

During the past year a questionnaire was sent to the Association membership requesting samples of papermaking fibers. The response to this request was excellent with several hundred samples being offered. The returned questionnaires are being studied by the Institute of Paper Chemistry staff to determine which samples will be accepted for the Fibrary which will be located at the Institute. The purpose of the Fibrary is to be the source which may be called upon by individuals or companies to supply them with fiber samples of known origin and history. These can be studied microscopically as a basis for determining the nature of undetermined fibers. This service was requested by the TAPPI Testing Conference held at the Mellen Institute in Pittsburgh, Pa., on Oct. 11–14, 1948. The need for such a service was considered to be urgent.

Student Members

By vote of our membership the junior grade of member was discontinued and a new grade of Student Member established. Since the junior grade was intended to apply primarily to members in colleges and those felt to be financially unprepared for the associate and active grades there was practically no negative votes. By inflation and general economic improvement of technical men in the industry coupled with the fact that membership dues have not advanced since 1921 the conditions leading to this Constitution amendment were obvious.

Munitions Board

The Association in many ways was able to contribute to the recent war effort. In line with the effort of the Federal Government to utilize the lessons learned during the war relative to procurement and stock-piling activities the Technical Association is being represented in the membership of the Packaging Advisory Subcommittee of the Munitions Board by the Association Secretary. Through this medium it will be possible to call for the assistance of qualified individuals in the Association and the industry if the need arises.

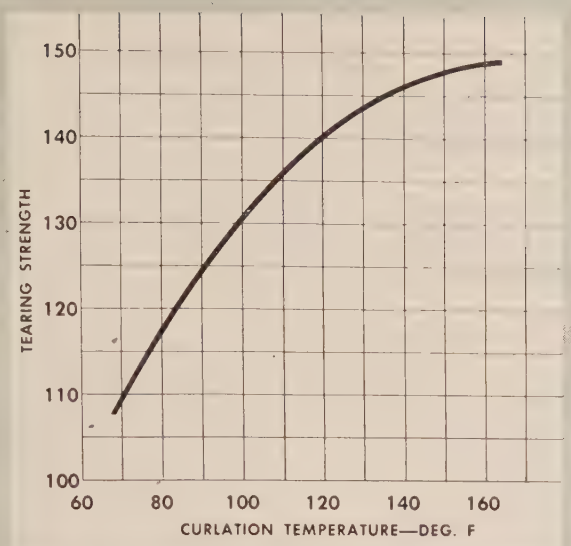
Employment

This report has made annual mention of the employment status of its members. It has always been a major interest of the Association to promote the creation of employment for technically trained individuals and to assist such persons in obtaining employment or in improving their employment status. Over the years the Association has been a successful intermediary in enabling companies to find competent employees and in planning individuals in positions. Employment of technical trained people in the industry has been quite stable and the Employment Service Department now appearing in *Tappi* has produced a large number of mutually beneficial results.

Local Sections

No new local sections were established in 1949 but during the past fall a group known for the present as the Lake Erie Papermaker's and Converter's Association was established in Cleveland, Ohio, and is serving a large area from Erie, Pa., to Monroe, Mich., and south to central Ohio. If it is evident that this group is likely to be supported in the future it is probable that it will eventually apply for a local section charter.

TEAR CURVE



Effect of Temperature During Curlation Using Power Consumption of 2.5 H. P. Days Per A. D. Ton on the Properties of

PREVIOUSLY UNDRIED NORTHERN UNBLEACHED SULPHITE PULP

TEST DATA

TEMPERATURE OF CURLATION °F	RAW*	70	120	160
FREENESS	835	835	845	856
MULLEN	70.8	62.1	52.6	37.8
TEAR	95	109	140	149
DENSOMETER	14.0	3.7	1.2	0.7

*WITHOUT CURLATION

NOTE: Description of the testing procedures employed by The Curlator Corporation laboratory will be provided upon request.

The CURLATOR† is a tool for altering the properties of pulp and paper to obtain qualities hitherto unachievable by mechanical means. The effects of CURLATION are controllable over a wide range by conditions of treatment. They vary with the raw material and may be described only in relation to a particular pulp.

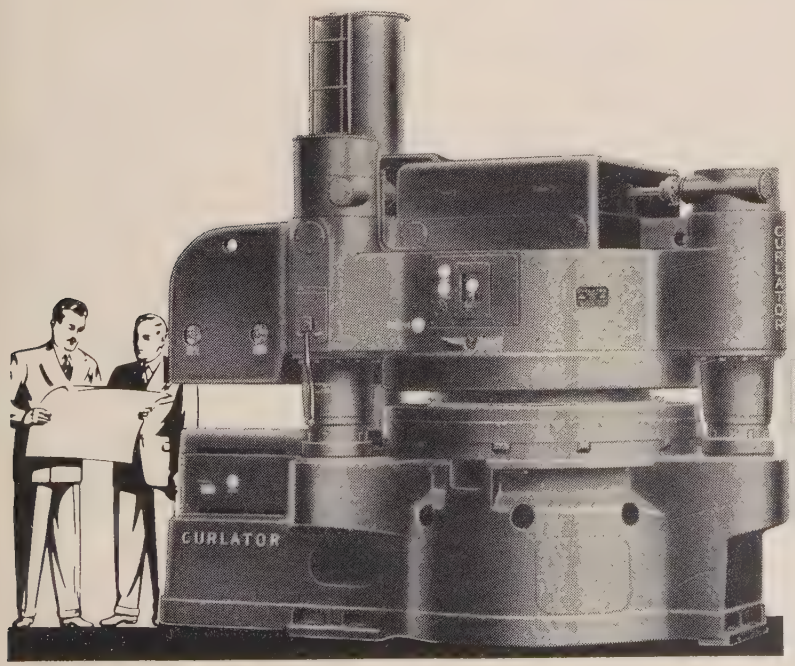
MAY CURLATION SOLVE YOUR PROBLEM?

CURLATION is a fully tested and thoroughly proved mechanical process. It not only produces a permanent change in the shape of pulp fibres, but also exerts a powerful de-shiving action, with negligible change in freeness.

The effects obtainable with CURLATION vary widely with the raw material and the conditions of treatment. In general, CURLATION tends to produce an easier beating pulp from which water is more easily removed.

Sheets of CURLATED pulp exhibit a more even textured matte appearance. In addition, the range of qualities obtainable from a given pulp is broadened.

Other important advantages exist. Your inquiries are invited.



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Corporation
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†T. M. Reg.—Curlator Corporation, Rochester, N. Y.

The Pacific Section sponsored the national fall meeting of the Association and the Kalamazoo Valley Section co-sponsored the TAPPI Coating Conference held at Grand Rapids, Mich., in the spring. All sections had a successful meeting year.

The Chairmen of the local sections elected during 1949 were as follows: *Pacific*—Walter F. Holzer, Crown Zellerbach Corp., Camas, Wash.; *Lake States*—George R. Sears, Institute of Paper Chemistry, Appleton, Wis.; *Delaware Valley*—John P. Weidner, Container Corp. of America, Manayunk, Pa.; *Kalamazoo Valley*—S. I. Kukolich, Lee Paper Co., Vicksburg, Mich.; *New England*—P. S. Bolton, Robert Gair Co., Uncasville, Conn.; *Ohio*—Arthur Thurn, Champion Paper & Fibre Co., Hamilton, Ohio; *Empire State*—C. E. Foster, Sealright Corp., Fulton, N. Y.; *Maine-New Hampshire*—John L. Parsons, Hollingsworth & Whitney Co., Waterville, Me.; *Chicago*—George A. Zinkil, Container Corp. of America, Chicago, Ill.; *Papermakers and Associates of Southern California* (unaffiliated)—Robert W. Stevens, Angelus Paper Box Co., Los Angeles, Calif., and the *Lake Erie Papermaker's and Converter's*—Lewis K. Burnett, Ohio Boxboard Co., Rittman, Ohio.

Divisions and Committees

The principal technical work of the Association is carried on by more than 70 committees in seven divisions. These committees conduct conferences, prepare standards, monographs, data sheets, carry out projects throughout the year. The details of these accomplishments will be published in the reports of these committees during the year. The following information is devoted primarily to personnel changes during the past year:

Engineering Division: George H. Pringle, Mead Corp., succeeded J. W. Hemphill, Johns-Manville Corp., as general chairman. The division sponsored the Fourth Engineering Conference of the Pulp and Paper Industry, held at Boston, Mass. Steam and Power Committee: Charles J. Sibler, West Virginia Pulp and Paper Co., succeeded J. E. A. Warner, Robert Gair Co., as chairman. Materials Handling Committee: A. P. Schnyder, Ebasco Services, Inc., succeeded George R. Wadleigh, Consulting Engineer as chairman. Drying and Ventilating Committee: M. L. Barker, Beckett Paper Co., succeeded A. E. Montgomery, J. O. Ross Engineering Corp., as chairman. Engineering Research and Machine Design Committee: Philip H. Goldsmith, Pusey & Jones Corp., chairman. Hydraulics Committee: This former subcommittee of the Research and Machine Design Committee was established in full committee status with K. J. Mackenzie, Eastman Kodak Co., as chairman. Mill Design and Economic Aspects Committee: Alvin H. Johnson, Consulting Engineer, chairman. Mill Maintenance and Materials Committee: M. F. Fogerty Sutherland Paper Co., succeeded Wm. McIntosh, Southern Corp., as chairman. During the past year three committees were added to the division. The Chemical Engineering Committee was transferred from the Research Development Division and reorganized with James R. Lientz, Union Bag and Paper Corp., succeeding R. P. Whitney, Institute of Paper Chemistry as chairman. The Electrical Engineering Committee was established with A. S. Goodrich, Hammermill Paper Co., as chairman. The Data Sheets Committee was established with Henry J. Perry, Paper Trade Journal, chairman.

Industrial Division: Werner Kaufmann, Kupfer Bros. Paper Co., succeeded Fred C. Goodwill, St. Regis Paper Co., as general chairman. Vocational Education Committee: B. E. Lauer, University of Colorado, chairman. Nonfibrous Raw Materials Committee: E. N. Poor, Hudson Pulp and Paper Co., chairman. Mill Instrument Control Committee: R. W. Porter Fritz Publications, Inc., chairman. Water Committee: A. S. Erspamer, P. H. Glatfelter, Co., succeeded Miss Louise E. McGrath, Booth Chemical Co., as chairman. Fibrous Agricultural Residues Committee S. I. Aronovsky, Northern Regional Research Laboratory, chairman. The subcommittee chairmen were: Procurement, Storage and Preservation, H. M. Blandin, Central Fibre Products Co.; Raw Materials Classification, S. I. Aronovsky; Pulping, B. F. Stahl, Terre Haute Paper Co.; Board and Paper Manufacture, M. F. Knack, River Raisin Paper Co.; and Testing, N. F. Wilson, Alton Boxboard Co. The Fibrous Agricultural Residues Committee sponsored a fall conference at Terre Haute, Ind.: Structural Fibrous Materials: John F. Campbell, Flintokote Co., chairman. Its subcommittee chairmen were Raw Materials Testing, E. M. Jenkins, Johns-Manville Research Corp., and Finished Products Testing, Emile Frederick, Jr., Celotex Corp.

Converting and Consuming Division: Ralph A. Wilkins, Bird & Son, Inc., general chairman. Containers Committee: H. T. Barker, Bird & Son, Inc. succeeded W. B. Lincoln, Jr., Inland Container Corp., as chairman; Graphic Arts Committee: R. H. Simmons, Government Printing Office, chairman; Wet Strength Committee: K. W. Britt, Scott Paper Co., chairman; Coating Committee: Werner Kaufmann, Kupfer Bros. Paper Co., chairman. The subcommittee chairmen were: Adhesives, Miss R. M. K. Cobb, Lowe Paper Co.; Defoaming Agents, W. B. Morehouse, NOPCO Chemical Co.; Mechanical Equipment, F. W. Egan, Frank. W. Egan & Co.; Pigments, W. R. Willets Titanium Pigment Co.; Raw Stock, W. A. Kirkpatrick, Allied Paper Mills; Testing Procedures, Miss Lois V. Hans, St. Regis Paper Co.; Gummed Paper, F. W. Farrell, McLaurin-Jones Co.; Lamination, J. E. Fenn, Industrial Consultant; Waxes, J. D. Clark, D. L. Ward Co. The Coating Committee sponsored a spring conference at Grand Rapids, Mich. Plastics Committee: E. C. Jahn, New York State College of Forestry, chairman. The subcommittee chairmen were: Resin Analysis, T. A. Howells, Institute of Paper Chemistry; Resins and Plastics, Herman Mark, Polytechnic Institute of Brooklyn; Plastics in Paper Converting, R. H. Mosher, Holyoke Card and Paper Co.; Fabrication and Structural Products, C. J. Straka, Westinghouse Electric Co.

Research Development Division: H. W. Bialkowsky, Weyerhaeuser Timber Co., succeeded G. J. Brabender, Marathon Corp., as general chairman. Bibliography Committee: C. J. West, Institute of Paper Chemistry, chairman; Fundamental Research Committee: Harry F. Lewis, Institute of Paper Chemistry, chairman; Statistics Committee: T. A. Pascoe, Nekoosa-Edwards Paper Co., chairman; Microbiological Committee: R. F. De Long, chairman; The chairman of the Testing of Mildew Resistance Subcommittee is B. F. Shema, Institute of Paper Chemistry; Patents Committee: Frank Makara, Patent Attorney succeeded C. W. Rivise of Caesar & Rivise as chairman. The Chemical Engineering Committee was transferred to the Engineering Division.

Pulp Manufacture Division: Fred C. Goodwill, St. Regis Paper Co., succeeded H. W. Bialkowsky, Weyerhaeuser Timber Co., as general chairman; Acid Pulping Committee: G. H. McGregor, Minnesota and Ontario Paper Co., chairman; Alkaline Pulping Committee: Henry Vranian, Chesapeake Corp. of Va., succeeded K. G. Chesley, Crossett Lumber Co., as chairman; Mechanical Pulping Committee: R. M. Drummond, International Paper Co., chairman; Chemical Products Committee: Arthur Pollak, Consultant, succeeded W. P. Lawrence, Champion Paper & Fibre Co., as chairman; Paper Deinking Committee: This committee has been temporarily suspended. No chairman has been appointed. (If sufficient interest is expressed this committee can be reactivated); Pulp Purification Committee: Ward D. Harrison, Riegel Paper Corp., chairman.

"Excelsior"

Paper Machine Felts

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CAMDEN, MAINE

MANUFACTURERS OF THE FIRST ENDLESS FELTS IN AMERICA

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The Trademark of Felts of Superior Quality for Every Grade of Pulp and Paper

Paper Manufacture Division: A. L. Sherwood, Sutherland Paper Co., general chairman; Preparation of Papermaking Materials Committee: Joseph J. Thomas, S. D. Warren Co., chairman; The chairman of the subcommittees were: Stuff Preparation and Sheet Formation: L. A. Moss, Whiting-Plover Paper Co.; Fillers Monograph: R. J. Proctor, Fitchburg Paper Co.; Significance of Sizing Tests: R. G. Mispley, Crown Zellerback Corp.; Starch in the Paper Mill, J. C. Bullard, Corn Products Refining Co.; Paper Making (Cylinder) Committee: James J. Harrison, Michigan Carton Co., chairman; Paper Making (Fourdrinier) Committee: N. R. Phillips, Champion Paper & Fibre Co., succeeded B. L. Kassing, Ecusta Paper Co., as chairman.

Testing Division: James d'A. Clark, Consulting Engineer, general chairman; Fibrous Materials Testing Committee: E. R. Schafer, Forest Products Laboratory, chairman; Nonfibrous Materials Testing Committee: J. P. Casey, New York State College of Forestry succeeded S. I. Kukolich, Lee Paper Co., as chairman; Wax Testing Committee: A. M. Heald, Marathon Corp., chairman. (This subcommittee of the Nonfibrous Materials Committee was advanced to full committee status during the year). Its subcommittee chairmen were: Sealing and Laminating Strength: G. C. Borden, Riegel Paper Corp.; Penetration and Hardness: E. R. Wiles, Bareco Oil Co., Flexibility: T. A. Howells, Institute of Paper Chemistry; Tensile Strength: J. W. Padgett, Moore & Munger; Blocking Resistance: M. W. Kane, Kalamazoo Vegetable Parchment Co.; Odor of Wax: L. F. Swec, H. P. Smith Paper Co.; Wax Stability: G. G. Rumberger, Marathon Corp., and Melting Point Distribution of Wax: F. H. MacLaren, Standard Oil Co. of Indiana. Pulp Testing Committee: L. V. Forman, Institute of Paper Chemistry; Optical Properties Committee: A. H. Croup, Hammermill Paper Co.; Microscopy Committee: C. E. Brandon, Aetna Paper Div., Howard Paper Mills, Inc., succeeded Thomas Fyfe, Eastman Kodak Co.; Paper Testing Committee: A. K. Warner, Skinner & Sherman, Inc., succeeded B. W. Scribner, National Bureau of Standards as chairman; P. W. Codwise is chairman of the Erasing Properties Subcommittee; Container Testing Committee: W. J. Balster, Don L. Quinn Co., chairman; Packaging Materials Testing Committee: L. E. Simerl, Marathon Corp., succeeded George R. Sears, Institute of Paper Chemistry as chairman; Chemical Methods Committee: Milton Fillius, Eastman Kodak Co., chairman. The Chemical Methods subcommittee chairmen were: Alpha, Beta, and Gamma Cellulose: A. S. O'Brien, Eastman Kodak Co. Disperse Viscosity: Peter Van Wyck, Hercules Powder Co.

Special Committees: Standards Committee: R. C. Griffin, Arthur D. Little, Inc., chairman; Research Appropriation Committee: John L. Parsons, Hollingsworth & Whitney Co., chairman; Joint Textbook Committee: George E. Williamson, Strathmore Paper Co., chairman.

R. G. Macdonald, *Secretary*

Geo. H. Mead Awarded TAPPI Medal

The eighteenth TAPPI Medal was awarded to George Houk Mead, Honorary Chairman of the Board of The Mead Corp., Chillicothe, Ohio.

Among Mr. Mead's contributions to the technical advancement of the pulp and paper industry, for which the medal was awarded, are the following:

1. Development of the viscose rayon pulp process with Arthur D. Little, Inc.

2. Paper Machine Coating: During the first World War, Mr. Mead felt that paper should be coated on the paper machine. Processes were developed and put into operation at Chillicothe wherein coating was applied without brushes to paper and dried on the paper machine driers.

3. Chestnut Corrugating Board: Although the semichemical pulping process was developed at the Forest Products Laboratory the commercial application was directed by Mr. Mead who built five mills in the Central South to utilize spent chestnut chips which previously had been burned as fuel. These mills manufactured 350 tons of paperboard per day.

4. Use of Calcium Carbonate and Calcium Magnesium Carbonate, waste material in the soda pulp mills, as a paper filler: The original patents for this process were held by the Raffold Co. of America, the use of these materials as a paper filler were developed by the Mead Corp. on Mr. Mead's initiative.

Mr. Mead was born and bred in the paper industry. His grandfather, Colonel Daniel E. Mead, moved from Cooperstown, N. Y. to Dayton, Ohio and was firmly established in the paper business in 1846. Colonel Mead's two sons, Charles D. and Harry Eldridge Mead were both associated with him in the family paper business. In November, 1876, Harry Mead married Marianna Phillips Houk of Dayton, and the oldest and only surviving child of this union was George Houk Mead, born Nov. 5, 1877.

Following a common-school education in Dayton, George Mead matriculated at Hobart College in Geneva, N. Y., and graduated with the degree of B.L. in 1897. He returned to Dayton and went to work in the Mead paper mill as a tour worker on a paper machine, working eleven hours on the day shift or thirteen hours on the night shift, which was the common practice at that time.

The twenty-year old tour worker quickly saw that to this practical experience he must add further schooling in chemical and mechanical engineering, and in the fall of 1898 he entered the Massachusetts Institute of Technology. In 1900 he graduated from M.I.T. with the degree of B.S. in Chemical Engineering.

Following his graduation from M.I.T. he went to work for the Cellulose Products Co., in Boston in order that he might be under the supervision of A. D. Little, one of the leading pulp and paper chemists of the time. Little was working on the development of viscose products and the first rayon produced in the United States was made in his laboratory in Boston.

In 1902, George Mead left the Cellulose Products Co. and spent two years in Chillicothe as a chemist, pulp mill foreman, and finally, local manager of the Mead Paper Company's mill. He established a laboratory at the mill.

The artificial silk business had now reached a semicommercial stage, and the General Artificial Silk Co. proposed building a mill at Lansdowne, Pa. and because of his work with Little and his knowledge of mechanical engineering, Mr. Mead was offered and accepted the job of building the mill. When it was completed, he took charge as General Manager and Treasurer and remained until the company was sold to the English Cortaulds Co. in 1905.

He had by now resolved to return permanently to the paper industry, and at the request of the Mead estate and certain bankers interested in the properties in Dayton and Chillicothe, undertook the reorganization of the Mead Paper Co., serving as Vice-President and General Manager from 1905 to 1912, and as President from 1912 to 1942.

George Mead's interests in pulp and paper have not been confined solely to the United States. In 1911, in association with Colonel H. E. Talbott, he organized the Lake Superior Paper Co. with a capitalization of $10,000,000. As Vice-President and General Manager of this company he entered the newsprint industry of Canada. Lake Superior Pulp and Paper Co. erected a mill at Sault Ste. Marie, Ont., which, along with his other activities he operated until 1913, when it was consolidated with the Spanish River Pulp & Paper Mills, Limited.

In 1914 Mr. Mead was asked to become Vice-President of the Spanish River Co., and in 1915 was elected its President, which office he held until 1928. During this period, the company doubled in size, and four other properties were developed in Canada under Mead's leadership—Fort William Paper Co. at Fort William, Manitoba Paper Co. near Winnipeg, Ste. Anne Paper Co. at Ste. Anne, and the Murray Bay Paper Co. at Murray Bay, Que. In 1928 these four companies and the Spanish River Co. were merged with the Abitibi Power and Paper Co., Ltd., to form the largest producer of newsprint in the world. The daily capacity of the Abitibi mills was over 2000 tons.

Another field that claimed a part of Mead's attention was the sale of newsprint to American publishers. In January, 1916, he organized The G. H. Mead Co. for this purpose, and it became the sole selling agent of the Abitibi Co. in the United States. The G. H. Mead Co. was acquired by the Abitibi Co. in 1933.

In 1930 The Mead Corp. was organized. This was the successor company to the Mead Pulp and Paper Co. By this time, in addition to the mills at Chillicothe and Kingsport there were properties at Lynchburg, Va., Sylva, N. C., and Harriman and Knoxville, Tenn. In order to devote more of his attention to this new group of mills, Mr. Mead relinquished active participation in the affairs of the Abitibi Co. although continuing for some years as Chairman of the Board.

George Mead has always felt that the business man should take an active interest in the affairs of government. In 1933, the Secretary of Commerce, Daniel Roper, formed the Business Advisory Council, inviting some fifty-two leading industrialists to let his department have the benefit of their advice in settling the pressing problems of our then depression-ridden nation. From 1933 to date, Mr. Mead has served on this Council, and was Chairman in 1936 and 1937. This Council serves in an advisory capacity to the Department of Commerce. In 1934 and 1935 he served on the Industrial Advisory Board under N.R.A. In 1941 was appointed to the National Defense Mediation Board, in 1942 Mr. Mead was appointed as an Industry Member of the War Labor Board, serving until 1944, and from 1945 to 1946, was a member of the Advisory Board to the Director of War Mobilization and Reconversion, as well as serving as a member of the De-Control Board in 1946. In 1947 Mr. Mead was appointed to the Commission on Reorganization of the Executive Branch of Government, and in 1948 was appointed to the E. C. A. Advisory Board.

In 1943 Mr. Mead was elected President of the American Paper and Pulp Association, serving one year in that capacity.

In 1946 Mr. Mead was one of a group of men and women who began a series of informal exploratory meetings to discuss the problems and opportunities of public school education in the United States, and the results of these meetings became known as the National Citizens Commission for The Public Schools, which has been quietly functioning ever since.

Mr. Mead served as Chairman of the Board of The Mead Corp. from 1942 until 1947. In 1947, when the corporation was starting in its second century of operations, and having devoted fifty years of his life to its affairs, Mr. Mead resigned as Chairman of the Board, and accepted the position of Honorary Chairman of the Board, which he still retains.

Remarks of Reuben B. Robertson, Sr.

Champion and Mead have been making similar *grades* and have been *competitors* and *technical enemies* for a half a century. They have been the kind of enemies who *respect* and admire each other.

Since Mead has not taken any of Champion customers in the last 30 days I can say we even comply with biblical *mandate* and *love* our enemies.

That is not difficult when a chap like George Mead is the General of an *allegedly hostile* army.

It has been well said that a successful company is built alike of tradition and invention—caution and experiment—conservatism and change. It blazes trails for the future and orients them by the pole star of the past. Its methods are flexible but its principles are adamant.

The Mead Company has been successful by *these* standards—successful because its organization is the elongated shadow of a really great industrial statesman. No one of my acquaintanceship has accepted the responsibilities of citizenship, and of industrial leadership, in a more selfless and earnest fashion.

His record of big jobs handled in a big way and in the public interest is one of which our industry can well be proud.

Time will not permit a full listing of the many jobs of national importance he has handled.

To mention a few—Member of National Mediation Board, Chairman Industry Section National War Labor Board, Chairman Business Advisory Council, Member Price Decontrol Board, Member Hoover Commission, Government Reorganization, and last but not least, President A.P.P.A.

TAPPI has chosen well the recipient of its Medal for Outstanding Achievement. In honoring George Mead, TAPPI honors itself.

Geo. H. Mead

Remarks of Geo. H. Mead

In response to the presentation of the TAPPI Medal by Reuben H. Robertson Sr. of the Champion Paper & Fibre Co., Mr. Mead remarked:

To the President and Members of the Technical Association:

I deeply appreciate the honor your Committee has been generous enough to confer upon me.

Whatever modest accomplishments I may have attained in the pulp and paper industry are due very largely to the splendid group of men who have been associated with me over the years, many of whom are Members of this Association, some of them probably here today. Therefore, in accepting this medal I want to acknowledge the debt I already owe your Technical Association and express my hearty approval of the way its affairs have been handled over the years by your able and progressive organization.

In America our scientists and technicians have developed a cooperative spirit and a frank and open intercourse in practically all industries that has been of great value to all concerned and we are fortunate in the pulp and paper industry to have the spirit of good fellowship constantly increased by the members of this Association.

As some of you know, I have spent a considerable time during the war years, and during the eight years preceding a limited portion of time, in contact with Washington through Government Councils and Committees. I was prompted by the feeling that closer association between Government and Industry was necessary to the sound operation of both.

Since the second World War, the necessity for such cooperation has greatly increased and I am now convinced that without it our Country will find itself in a sorry plight and the world in a correspondingly similar situation.

The leadership that has been forced upon the United States by developments of the past ten years will require the maximum intelligence of all thinking people in America and I am convinced

that the technical men, who have contributed so much to the progress of the nation, must now use the same general procedures for the betterment of Government and the solution of international problems necessary to the peace of the world.

It is, therefore, my hope that a strong, vital group such as your own will dedicate a part of its time henceforth to the political, economic and social problems which must be met and solved if we are to have a world and a Country in which to continue our individual freedoms and successful industrial progress.

Again, I thank you for your kind consideration.

TAPPI 1950 Executive Committee

As reported by the Tellers Committee, A. E. Bachmann of the Missisquoi Corp., Sheldon Springs, Vt., and K. P. Geohegan of the Howard Paper Mills, Inc., Dayton, Ohio, were re-elected President and Vice-President, respectively, of the Technical Association. K. O. Elderkin of the Crossett Paper Mills, Crossett, Ark., was re-elected to serve a three-year term as a member of the Executive Committee.

Richard P. Price, Vice-President and General Superintendent of the Hammermill Paper Co., Erie, Pa., was elected to serve a one-year term, completing the three-year term of W. B. Lincoln, Jr., of the Inland Container Corp., who resigned. Mr. Price was born at Whitford, Pa., in 1902 and graduated from the Massachusetts Institute of Technology as an engineer in 1925. He joined the Hammermill organization in 1926, and in addition to being a Director of the Hammermill Paper Co., is also Director and Vice-President of the Grays Harbor Pulp and Paper Co.

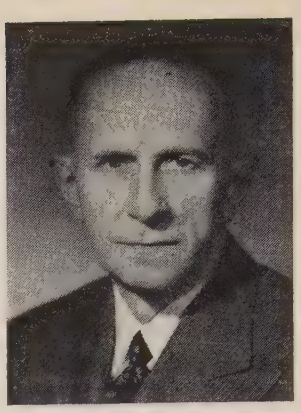
In addition to Mr. Elderkin, Messrs. Jacobs, Kumler, and Shipman were elected for three-year terms.

Milton Jacobs, Associate and Director in charge of the Pulp and Paper Mill Engineering Dept., Chas. T. Main, Inc., 80 Federal St., Boston, Mass., was born at West Stewartstown, N. H., in 1891, and graduated as a civil engineer from Norwich University in 1912. From 1912–1914 he was a maintenance draftsman for the Burgess Sulphite Mill, Brown Co., Berlin, N. H. From 1914–1921 he was a construction engineer for H. P. Cummings Construction Co., Ware, Mass., specializing on paper mills and hydroelectric development. (During this period he served as a 2nd Lieut. in the Army, C.A.C. during 1918–1919). From 1921–1923 he was a designing engineer for the Management, Engineering, and Development Co., in Dayton, Ohio. From 1923–1933 he was associated with H. S. Taylor at Dayton and Montreal. From 1933–1939 he was Chief Engineer of the Brown Co., in Berlin, N. H., following which he joined the Chas. T. Main organization. In TAPPI he was recently Chairman of the Mill Design and Economic Aspects Committee of the Engineering Division.

Ralph W. Kumler, Paper Chemicals Dept., American Cyanamid Co., New York, N. Y., was born in De Graff, Ohio in 1889 and graduated from Wittenberg College in 1913, later taking graduate work at the University of Pennsylvania. He joined the Hercules Powder Co., in 1917, as chemist and operating supervisor. From 1921–1928 he was chemist and superintendent of Jessup and Moore Paper Co., Wilmington, Del. In 1928 he became associated with Bennett, Inc., Cambridge, Mass. This Company was later merged with the American Cyanamid Co., with which he has been for the past 22 years.

George E. Shipman, Technical Director and Groundwood Superintendent, Donnacona Paper Co., Ltd., Donnacona, P. Q., was born at Connington, Ont., in 1902 and graduated as a chemical engineer from Queens University in 1924. From 1924–1926 he was shift superintendent of the Soda Pulp Mill of the Tonawanda Paper Co., Tonawanda, N. Y. In 1926–1927 he was Superintendent of the Soda Pulp Mill of the Howard Smith Paper Co., at Cornwall, Ont. From 1927–1929 he was General Superintendent of Cellulosa Cubana, Tuinucu, Cuba, and joined the Donnacona Paper Co., Ltd., in 1929 with which he is now associated. Mr. Shipman was Chairman of the Technical Section of the Canadian Pulp and Paper Association in 1943–1944 and won the $1000 prize award given by the Ontario Paper Co., recently for his paper on "A Method to Use up to 40% Birch and Poplar in a Newsprint Sheet."

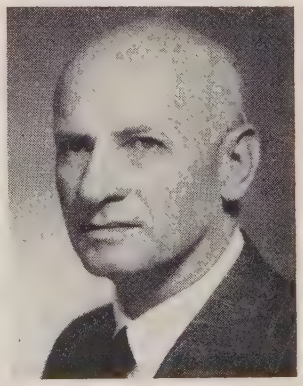
Other members of the Executive Committee whose terms continue are H. W. Bialkowsky, Weyerhaeuser Timber Co., Longview, Wash., F. C. Goodwill, St. Regis Paper Co., Kalamazoo, Mich., M. L. Downs, Thilmany Pulp & Paper Co., Kaukauna, Wis., G. H. Pringle, Mead Corp., Chillicothe, Ohio, Werner Kaufmann, Kupfer Bros. Paper Co., Chicago, Ill., A. L. Sherwood, Sutherland Paper Co., Kalamazoo, Mich., and J. d'A. Clark, Consulting Engineer, Longview, Wash. R. G. Macdonald continues as Secretary-Treasurer.



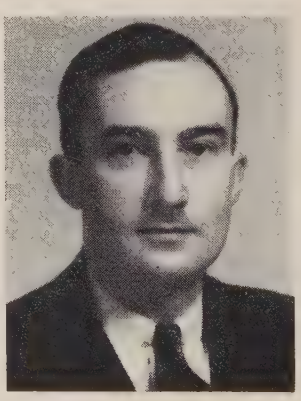
Kenneth P. Geohegan

Karl O. Elderkin

Milton Jacobs



Ralph W. Kumler



George E. Shipman

Richard P. Price

REPORTS AND DISCUSSIONS

Presented at National and Regional Conferences

Condensations of Annual Meeting Papers

Following are condensations of a number of the papers that were presented at the annual meeting of the Technical Association (Feb. 20–23, 1950). Most of these papers will be published in full in subsequent issues of *Tappi*.

The Use of Radioisotopes for Process Control in Pulp and Paper Manufacturing, A. P. Schreiber

Radioisotopes, one of the most important groups of byproducts of atomic energy developments, are already proving of assistance to a large segment of industry and science. To accelerate their utilization a greater realization of their potentialities and necessary specialized techniques in using them is required. One of the most promising uses of immediate application to industry is in gaging and physical measurement problems. The principles of a beta ray absorption gage for continuous noncontacting measurement of basis weight are outlined. An even newer development, a gage utilizing the principle of beta radiation backscattering can be used for continuously measuring extremely thin condenser and cigarette paper or for gaging coatings such as barium sulphate on photographic paper.

The use of radioisotopes as tracers for following constituents through a series of chemical reactions or to carry out flow studies are discussed, and examples of tracer techniques for pollution problems and material balance studies are outlined. The pulp and paper industry will also receive a great deal of indirect benefit as a result of research work done with the aid of radioactive tracers by metallurgists, petroleum research chemists, and others who contribute to the research and development of the components of which a paper mill is constructed.

Examples of contributions of radioisotopes toward furthering basic knowledge of metallurgy, the mechanism of friction, and lubrication are discussed. While it is not anticipated that radioisotopes will cause immediate widespread radical changes in industry, they have already proved to be of great value as a versatile tool in many projects which were heretofore either very difficult or actually impossible to carry out with conventional methods.

Modulus of Rupture Test for Paraffin Wax, L. E. Hoag

A simple apparatus and procedure is described for determining the modulus of rupture of paraffin wax. This property has been found to be of considerable importance with respect to the serviceability of paraffined fiber milk containers. Data are presented relating the stiffening effect of paraffin on paper to the modulus of rupture of the wax used.

Small slabs of paraffin wax, prepared by casting on water, are broken by applying a load midway between two supports. The load is applied to a bar resting across the slab by flowing water into a plastic bucket suspended from the ends of the bar. The apparatus automatically diverts the water stream from the bucket at the moment of break and the modulus in psi. is calculated from the load and the dimensions of the slab at the point of break.

This test has been in use in four different American Can Co. fiber milk container producing plants since 1945 and has been applied on a routine basis to all shipments of paraffin wax received for use on fiber milk containers. Data, showing the results of the test on four samples submitted to seven different laboratories using this test are presented as well as a series of ten determinations run on the same sample in one laboratory.

The results of breaking the slabs, air side down, are compared with those obtained when the specimen is broken, water side down, and the conclusion reached that the modulus of rupture should represent the average of the same number of specimens broken each way. Equipment for performing this test is commercially available from Thwing Albert instrument Co., Philadelphia, Pa.

The Dominion Engineering Vacuum Vat, C. S. V. Hawkings

This paper is an informal description of the new Dominion Engineering vacuum cylinder vat with a discussion of the main operating characteristics and the results obtained to date.

A Rapid Instrument for Fractionating Pulp, A. E. Reed and James d'A. Clark

The new four-screen classifier developed by Clark is described and its operating procedure given. This instrument divides a 5-gram sample of pulp into four fractions plus debris, in 4 minutes.

Reference is made to the method of calculating the weighted average fiber length by weight of a pulp sample from classifier data. This method was published earlier and is not repeated in detail. The operating conditions and the weighted average fiber length of the fibers in each fraction were determined experimentally using Clark's projection method. These fiber lengths were as follows: On 14, 3.85 mm.; 14/28, 2.70 mm.; 28/48, 1.70 mm.; 48/100, 0.95 mm.; through 100, assumed 0.10 mm.

The distribution of fiber lengths was plotted to verify the above method. It was found that in this classifier the weighted average fiber length by weight in each fraction was 8% greater than the arithmetical average fiber length.

Mill data are presented to demonstrate the usefulness of this instrument and method in pulp refining studies.

Development of the Cowles Side Drive Pulper, J. M. Kelly and Edwin Cowles

This paper describes the hydraulic flow characteristics of a fast running, small diameter pulper impeller and shows that the "density of energy dissipation" is an important factor in the pulping and defibering of paper stock. The step by step development of the Cowles Side Drive Pulper is briefly described. The final pulper utilizes a 36-inch diameter impeller running at relatively high speed for fast pulping, and the tub is designed to assure good circulation and mixing of stock with practically no splashing, quck submergence of floating material, and fast dumping. The high-speed drive is light and relatively inexpensive and its location permits easy accessibility. The height of the 2000-pound pulper is so low that it can be located directly on top of a stock chest. Handsheets and horsepower per ton per day data are presented for various types of furnish.

Application of the Duotrol to Jordans and Refiners, T. Agronin

The problem of providing remotely operated equipment for accurate adjustment of jordan and hydrafiner plugs has been given considerable attention by the Shartle-Dilts organization for the past ten years.

The question of pressure control vs. power control was the subject of an exhaustive study made in 1945 by the Dilts Laboratory. An analysis of numerous laboratory and field tests indicated that time-horsepower control gave more uniform results than the time-pressure control.

It was found that results obtained on the time-horspower basis correlated, and that results could be predicted for changes in such factors as time, power, consistency, and freeness. This condition, however, was not true for the time-pressure control as the results obtained did not follow a typical curve, but were erratic and unpredictable whenever conditions were changed. On this basis a program of development and field testing was started which resulted in the present design of the hydrafiner and jordan Duotrol.

The Duotrol consists of a mechanical plug adjusting mechanism which is operated by a gear head motor. This motor adjusts the plug in or out to hold a predetermined power setting on the hydrafiner or jordan driving motor. The impulses are transmitted from the driving motor to the adjusting motor by means of a contact-making ammeter or wattmeter. Any change in power requirements of either the hydrafiner or jordan is instantly compensated by the plug adjustment through this ammeter or wattmeter control.

The results of these installations have been very interesting. In the case of the hydrafiner, a constant application of power has indicated that there is a saving of approximately 20% in power for the same amount of work done. In the case of the jordan, mills have installed it for its remote control setup whereby the jordan can be operated from a control panel on the machine floor, and also for its ability to maintain uniform fiber development characteristics.

The Vortrap—as Applied to the Paperboard Industry, H. E. Ingalls

The Nichols Engineering & Research Corp. has developed larger Vortraps with new features for special applications in the paperboard industry.

The 8 and 10-inch Vortraps have been developed particularly for the removal of large quantities of solids and foreign matter from all kinds of baled waste paper stocks. This paper describes this application with special emphasis on the layout as it may apply to an existing, as well as new, stock preparation systems.

Two regular types of operation are discussed, namely, the standard and automatic methods. The standard operation follows long established procedures by which foreign matter is removed and collected in a waste receiver which is emptied manually. The automatic operation involves the use of a new, specially designed automatic rejects discharge valve which permits a continuous discharge of rejects, and is very important in handling high dirt content stocks. This valve is equipped with a multiport rotor with rubber vanes to prevent binding and is usually driven at a constant speed of 2 r.p.m. Water at uniform pressure is used to control the loss of fiber in the rejects and insure trouble-free operation. This Vortrap system is effective in the removal of sand, dirt, clips, pieces of steel, glass, foil, rubber bands, and similar material found in baled waste papers. The Vortrap allows a compact layout and replaces settlers and similar equipment.

Economies result from a cleaner stock throughout the system. Reports of increased machine speeds, increased production due to fewer breaks on the paper machine, higher tests, and better quality board are common with all large Vortrap users.

Further direct economies result from decreased maintenance on jordan and refiner fillings, screen plates, wires, calender rolls, and other equipment in the paper machine system.

Developments in Methods of Treating Strawboard Wastes, Don E. Bloodgood

In introduction, the previous work on the anaerobic digestion of strawboard wastes is discussed and the conclusions are given. The next step in studying the problem was the designing of a pilot plant. The necessary considerations that must be taken into account in designing, locating, and constructing a pilot plant are pointed out. In order to conserve digestion tank capacity it was decided to treat only the rotary-beater-washer wastes by the anaerobic process it being believed that the machine wastes would be about equal in waste concentration with the effluent from the anaerobic process.

The anaerobic digestion process was started with digested sewage sludge. The details of starting the process are given. The available waste to be treated had a B.O.D. of 3560 p.p.m. as compared to a B.O.D. of 955 p.p.m. for the total waste used in the laboratory tests.

The removal of total solids and B.O.D. obtained by primary sedimentation were 21.6 and 31.0% indicating quite effective treatment by sedimentation.

The digestion tank was maintained at about 33°C. which is approximately the average temperature of the waste being treated. The B.O.D. reduction amounted to 0.0475 pound per cubic feet per day with the production of an effluent with a B.O.D. of about 135 p.p.m. The main difficulty in operation has been the bulking of the sludge. This resulted in a problem in sedimentation in the secondary settling tank. This difficulty was not believed to have been caused by the accumulation of solids because data indicated no increase in solids concentration in the digestion compartments even with no wasting of sludge.

Laboratory tests have been conducted to determine the relative values of ferric chloride, aluminum sulphate, ferric sulphate, and straw pulp as aids in filtering primary sludge. The indications are that all of these agents make the sludge filterable.

On the basis of known methods estimates have been made of plant sizes in order to present a better idea of the plant that would be required should it be built today. It would seem that it would be advisable to continue studies to see if material reductions in treatment units and costs of operation cannot be made.

Improved Straw Pulp for Corrugating Paper, H. M. Sutcliffe, S. I. Aronovsky, R. M. Wilkinson, W. D. Burnham, W. A. Phillips, and E. R. Carpenter

A large number of experimental cooks were made on wheat straw varying the amounts and kinds of chemicals in an attempt to produce improved pulps for corrugating. This work was part of a cooperative program between the strawboard industry and the Northern Laboratory and was carried on with the active collaboration of personnel from several strawboard mills.

The chemicals used were lime, caustic soda, sodium sulphite, singly and in various combinations. The pulps prepared with caustic soda or sodium sulphite and with combinations of these two chemicals were distinctly stronger than lime-cooked pulps. The optimum results in this series of experiments were obtained with 6% NaOH, 10% Na_2SO_3, 2% NaOH plus 4% Na_2SO_3, and 2% Na_2SO_3 plus 4% Na_2CO_3. The results indicated that suitable refining of straw pulp may be fully as important as the method used in preparing the pulp. Because of its high hemicellulose content, straw pulp is an excellent material for producing corrugating paper with high-crush resistance.

The results of this work offers the operating strawboard mills a wide latitude in choice of cooking chemical to produce the desired improved product consistent with the variation in methods and equipment used in each mill.

Processes Being Used in Europe for the Manufacture of Straw Pulp, Joseph E. Atchison

This paper discusses observations made by the author during a 5-month survey of the pulp and paper industry of seven of the western European countries. During this time an investigation was made of the present and potential utilization of straw in these Marshall Plan countries. A complete discussion is given of the elaborate straw preparation and cleaning equipment which is used by many of the European mills. The pulping processes discussed include both those in which conventional digesters are used and the various continuous processes in use in Europe. Processes using conventional digesters include the traditional lime process, the soda and sulphate process, and the monosulphate process. Continuous processes include the Celdecor, Pomilio, Huguenot, and others. One unusual process discussed which does not fall in either of these categories is the Marsoni cold caustic process being used in Italy.

A Laboratory Corrugator for 9-Point Medium, Norval F. Wilson

A working model of a laboratory-type corrugator was built and samples of corrugated board were produced using the same paper that was run on a commercial corrugator. The operation of the laboratory device involves the formation of flutes from a metal plate replica of single-face corrugated board. An electric heating unit provides suitable temperatures. Samples produced with this device always have perfect flute formation. The laboratory tests therefore show optimum quality on the medium used. Some special paper samples have given much higher flat-crush tests than any produced commercially. The effects of moisture in the corrugating medium, the degree of moldability under higher temperatures, the influence of adhesive formulations, and other factors which enter into the production of better corrugated board are being investigated. A new model of the laboratory corrugator will be demonstrated.

Mechanism of the Retention of Beater Added Urea Resins, Manuel N. Fineman and I. J. Gruntfest

Review of the literature on the application of urea-formaldehyde wet-strength resins to paper shows that controversies exist about both the mechanism of the process and the performance to be expected.

Experiments described leave no doubt as to the importance of the ionic character of both resin and pulp to the mechanism of retention. There appears to be no reason to isolate the problems of urea resin retention from those of other beater additives such as rosin, dyes, fillers, and melamine resins.

Cationic urea resins are found to give high efficiencies even on thoroughly bleached pulps. Statements about the performance of urea resins as a class are shown to be precarious, however, unless both resins and pulps are defined in detail.

Neoprene Latex in the Paper Industry, R. H. Walsh, H. H. Abernathy, W. W. Pockman, J. R. Galloway, and E. P. Hartsfield

The paper industry is familiar with elastomer latices mainly as saturants and adhesives and has not considered them as pulp additives except in a few cases where relatively large amounts of elastomer have been added at the beater to produce imitation leather-type products. Recently it has been found that paper made from pulp properly treated with small amounts of Neoprene latex Type 735 possesses a highly desirable combination of properties. Further, this latex can be used in larger percentages to produce products similar to those produced by saturation. The latex is added to the pulp by an exhaustion procedure. Details of the process are described. Data illustrating the high wet strength, good dry strength, folding endurance, and other properties of the neoprene treated paper are given.

Permanence of Wet-Strength Paper, C. S. Maxwell and W. F. Reynolds

The permanence of wet-strength paper is discussed from two angles (1) permanence of the wet-strength properties and (2) permanence of the paper itself. The factors mentioned that affect the permanence of the wet-strength properties are: nature of the wet-strength agent, pH of the paper during storage, temperature and humidity during storage, degree of cure of the wet-strength agent, and action of microorganisms. In regard to the permanence of wet-strength paper itself it is pointed out that many of the tests established for predicting the permanence of normal paper are unreliable when applied to the usual wet-strength papers. Tests that are affected are disperse viscosity, copper number, extracted pH, and folding endurance before and after oven aging.

The Instron Tensile Tester, George S. Burr and Harold Hindman

A description is offered of the newly-developed Instron tensile tester which makes use of electronic principles in weighing of the

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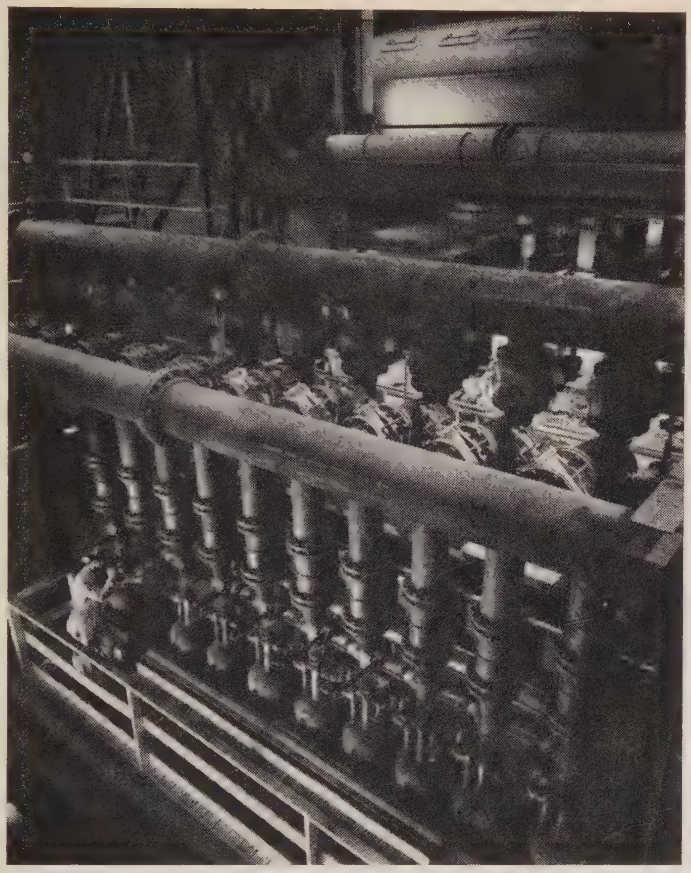

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tensile forces and in controlling the sample extension with the load-elongation data plotted autographically. The design of the instrument is such as to make it suitable for the sensitive measurement of a wide variety of materials, of which paper is a prominent example. A discussion is presented of certain techniques available for the evaluation of the various physical characteristics of paper, including the tensile strength, yield point, elastic modulus, energy absorption, and creep properties.

The Softening Mechanism of Paper Plasticizers, P. E. Nethercut

Although softening agents have long been employed in the paper industry to produce more flexible sheets, the nature of the plasticizing mechanism is still not understood. The present study is concerned with the effect of plasticizers on individual fibers. An instrument has been developed for measuring the flexural rigidity of fibers and filaments and also of paper sheets. Wood fibers proved too short to be used in this test and, therefore, Cordura filaments and ramie fibers and sheets were employed. The effect of water, ethylene glycol, glycerin, sorbitol, urea, and calcium chloride was investigated. The stiffness of the individual fibers is probably not highly significant in determining sheet stiffness, especially in the plasticized sheet, although this could not be definitely demonstrated experimentally.

The Role of the Chemical Engineer in the Pulp and Paper Industry, G. W. E. Nicholson

Until fairly recently, about 10 to 15 years ago, the activities of the chemical engineer and the chemist were largely limited to the laboratory, testing raw materials, and samples of chemicals from the processes as well as samples of pulp and paper. In those days he did not participate very actively in the actual operation except in a more or less advisory or service capacity. However, in recent years a greater appreciation of the importance of the graduate engineers knowledge developed with the results that they have contributed materially to the progress of the pulp and paper industry.

It is believed that the chemical engineer has a tremendous field open to him. However, a plan should be worked out so that he may obtain practical experience as well as being able to contribute to the welfare of his company. Such development plans as well as opportunities for the chemical engineer are discussed.

Stainless Clad Steel for Digesters, W. H. Funk and E. H. Wyche

Several advantages to be gained by using stainless clad digesters for sulphate and sulphite pulping are discussed. The selection and application of the proper type of stainless clad steel is emphasized as a means of reducing maintenance costs and total costs per ton of pulp.

Corrosion in Sulphate Pulp Digesters, T. C. Johnson

A study of the corrosion problems experienced in 20 digesters at the Union Bag & Paper Corp.'s Savannah plant is presented. Although the original digester service was from 12 to 14 years, newer digesters installed in 1947 and 1948 appear to be corroding so rapidly that a life of three to five years is all that can be expected. All digesters have been operated under the same service conditions.

A procedure has been adopted for measuring the digester plate thicknesses using an "Audigage" manufactured by the Branson Instrument Corp. The thickness measurements are plotted and compared with previous measurements to determine the rate of penetration of the plate. A visual inspection of the surface conditions is also recorded. Penetration rates of 0.025 to 0.040 inch per year are typical in the older digesters but newer units are corroding at rates varying from 0.075 to 0.143 inch per year.

The selection of replacements is difficult because of the lack of experience with alloys and carbon brick linings. In addition, the corrosion resistant qualities of carbon steel are obviously poorer now than previously. The problem of digester corrosion seems to be one which cannot easily be solved by one mill and calls for considerable additional study.

The Stacomizer—A Continuous Roller Press, R. J. Chambers and K. C. Logan

A novel type of hydraulically actuated continuous roller press has been invented, constructed, and tested. This Stacom press or Stacomizer is novel in design possessing a free-floating ring which runs between two rolls. The material being pressed passes between the inner roll and the inner surface of the ring. This design gives an acute angle to the nip and permits pressures to be developed which would reject the feed in a normal type of press.

The initial commercial model was built to dewater bark and was subjected to a series of trials. The bark was discharged in a finely-divided state suitable for conveying or burning, and generally possessed a moisture content of 50 to 55%.

Feed rates varied with the slipperiness of the bark and averaged about 70 tons of moisture-free material per 24 hours. Rates as high as 120 tons were secured, but with very slippery bark, the feed rate dropped to 40 to 50 tons.

Preliminary investigations were conducted to evaluate the press for other applications in the pulp and paper industry.

Industry's Stake in the Ohio Valley Pollution-Abatement Program, Edward J. Cleary

A narrative discussion of the composition, policies, and objectives of the Ohio River Valley Water Sanitation Commission. This account of how the Commission operates is based on an actual case history when a proposed industrial operation in one state indicated a pollution problem affecting other states in the Ohio River Valley. The report details the conclusions reached by the Commission and the basis for its decisions.

Physical Factors Involved in the Clarification of Paper Mill Effluents, Harry W. Gehm

The design and operation of common types of flotation and sedimentation devices in use for the clarification of paper mill effluents are reviewed in respect to the physical factors involved in their functioning. Effects of variables, unit design, appertenances, and general layout is discussed. Optimum results obtainable under conditions of continuous operation are pointed out. Particular reference is made to the collection and thickening of sludges integral to clarifying devices and to the theoretical and practical requirements which must be met to obtain satisfactory results. Advantages and limitations of presently applied methods are reviewed.

The Operation and the Application of the Waco Filter, Joseph K. Perkins

The Waco filter is a mechanical filter used for the removal of suspended solids from liquids. It has high efficiencies when used as a raw water filter, paper machine saveall, and as a mill sewer catchall saveall.

Other applications, which are successful, include filtration of black liquor in the kraft process giving filtrates of 3 p.p.m. going to the evaporators, filtration of syrups, and filtration of liquids containing granular materials.

In principle the Waco filter is the only mechanical filter which forms its own filter paper through which liquid is filtered continuously.

The Operation of the Cyclator in White Water Recovery, F. A. Eidsness

The Acme Paper Board Division of the Federal Paper Board Co., Reading, Pa., produces manila-lined tube and can board and various specialty papers. White water wastes resulting from the process were discharged into an adjacent creek and due to action taken by the Pennsylvania State Sanitary Water Board waste treatment had to be practiced prior to discharge. The consulting engineer's investigations indicated that the waste water could be effectively coagulated with an alum dosage in the range of 5 to 7 grains per gallon with the addition of 3 to 5 p.p.m. of activated silica.

Several months ago a Cyclator with necessary control and chemical feed equipment was installed for treatment of these wastes. Alum and activated silica are fed into the primary reaction zone of the unit and chemical reactions take place in the presence of previously precipitated particles. These particles are recirculated and discharged to the outer zone of the tank where larger particles settle to the bottom for thickening and removal, the lighter particles being recycled into the inner zone for increase into larger particle size. The clarified liquor flows over the peripheral weir to the stream.

After the plant had been in operation several weeks it was noticed that the precipitate would rise periodically in the outer portion of the unit and during periods of manufacture when titanium filler was used good coagulation was not obtained. Investigation indicated that the floating particles were caused by air entrainment of the coagulated fibers. Further investigations indicated that if the white water was reduced to a thin sheet, this air did separate and coagulated particles settled properly. Within the past month an aerator of the cascade type has been installed which has eliminated this difficulty. It was further found that proper coagulation of the wastes when titanium filler was used could be effected at higher alum dosages. Composite samples of influent, effluent, and underflow were analyzed during a 5-day, period the latter part of November. Although concentrations of the underflow have been obtained over 50,000 p.p.m. the average consistency is in the order of 25,000 p.p.m. The average suspended solids of the influent are in the order of 200 to 300 p.p.m. and effluent 25 p.p.m.

Economic Considerations in White Water Treatment, V. J. Calise

This paper deals with various types of equipment now available for reducing loss of stock in white waters from pulp and paper mills. In particular, two modern designs of reclaimers are described in detail, both embodying the principle of contacting the incoming white water with previously accumulated solid pre-

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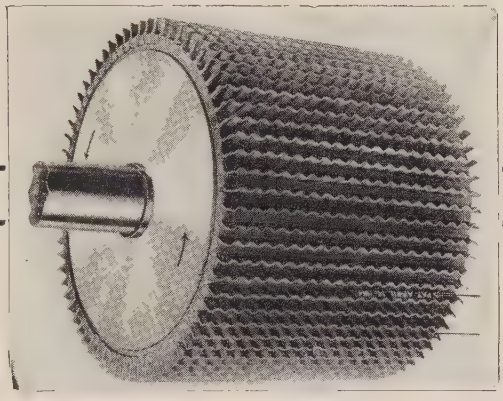

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cipitates and stock in order to effect virtually complete removal stock from the white water.

The advantages and possibilities of reusing clarified white water and recovered stock and the necessity for solving the problem of stream pollution are all discussed. The two modern white water reclaimer designs are described in terms of minimizing initial investment, minimizing long term operating cost, and tailoring the equipment to fit specific plant-operating conditions.

An actual example of a complete engineering calculation of such a reclaimer installation is shown with equipment costs, installation costs, operating costs, and savings obtained.

Flow sheets of several other typical plants are shown and cost data given.

Control of Sewer Losses, John G. Dobson

Loss of chemicals and fiber to the sewer can be substantially reduced by continuously surveying and controlling these losses. At the same time substantial reduction can be made in stream pollution. The first step in such a survey is accurate measurement of flow which can be done with Venturis, orifice plates, or in most cases weirs or flumes. The next step is accurate sampling, integrated in terms of total flow. This can be done by sampling pumps actuated so as to operate for times proportionate to the actual flow. The samples should be analyzed for the important constituent, and the results of analysis made available to the men responsible for operating the particular portion of the plant. The pump should be selected taking into account the amount of semisolids present in the waste. Sampling points should be selected so that a truly representative sample is obtained. Instantaneous readings, and signals of changes of chemical compositions of the waste, can be obtained by the use of conductivity instruments. In this way an operator can be warned when a sudden increase in concentration of one of the waste materials occurs.

Some Factors Affecting Slime Formation and Freeness in Board Mill Stock, Willem Rudolfs and Nelson L. Nemerow

Recirculation of white water is a common practice in most paperboard mills as a method of pollution abatement and of conservation of fiber, filler, and water. Slime is one of the major nuisances resulting from such recirculation. The slime causes a measurable decrease in the drainage rate of the machine stock.

A laboratory handsheet machine was designed and constructed to measure the drainage rate (freeness) of recirculated white water. Significant results can be obtained with this machine when sufficient slime is formed to cause a decrease of only 2 seconds in the drainage time.

It was found that slime forms to some extent when white water is recirculated without a pH control and within a temperature range of 20 to 37 °C. The growth as measured by freeness will vary from 20 to 250%, and also the optimum growth temperature will vary slightly from one mill to another. Slime formation is always preceded by a period of about 5 days during which the pH of the recirculated white water drops. Recirculated white water builds up in dissolved solids, and once these solids are seeded with the proper food and the microorganisms are acclimatized, slime will form. However, a pH of 4.5 or a temperature of 50 °C. was found to prevent slime growth. The pH can be controlled with alum or, better, with sulphuric acid. This slime growth is inhibited by replacing the nonsettleable portion of the white water with fresh water before recirculating. Replacing the settled fiber with fresh dried paperboard stock reduced slime growth by only 50%. Slime formation is greatly stimulated by casein, slightly stimulated by starch, and not affected at all by rosin.

The Beater Addition Process for Producing Laminating Papers, Francis H. Snyder, L. Spiwak, and Alfred E. Moyer

The beater addition of resins for plastics laminates has long been of considerable interest but has not proved feasible until this past year when a new group of water-insoluble phenolic resins was introduced. The procedure for addition of these resins to pulp is simple and direct, and difficulties previously encountered in attempts to add resins in the beater are eliminated. Freeness is increased upon addition of resin, permitting greater machine speeds. Retention of resin and fines in open systems is high, and 94 to 98% yields obtain at resin inputs from 1 to 60%. Broke is readily recovered by simple defibering. Since the resin completely surrounds each fiber, stocks prepared in this manner differ from off-machine saturated types in that fibers are bonded together with resin in the former, and by hydrocellulose in the latter; this difference in physical structure results in significant changes in physical and molding properties. Improvement are noted in impact, tensile, and flexural strengths, cold-punchability, machinability, post-forming. Special electrical and light-stable decorative grades are available. Stocks may be pigmented and further modified by elastomer latices. Low-cost decorative laminate core-stocks are produced by adding relatively small amounts of resin to hardboard pulps. A redwood fiber-resin combination also indicates considerable promise for core-stocks. Papers containing 5 to 10% resin can be off-machine impregnated at considerably greater speeds, with improved physical properties. A backing sheet has been developed which permits bonding of laminates to plywood, etc., without prior sanding. Asbestos-filled stocks may be prepared containing up to 60% resin, and molded at 50 p.s.i. Honeycomb-core papers are less brittle, and physical properties are not diminished by wetting; similar improvements are obtained with plywood masking overlays. Most of the developments described are in commercial production.

Formulation and Properties of Laminating Varnishes, C. B. Bennett

The conventional laminating varnish is a solution of a thermosetting resin in water or water and a solvent, such as ethyl alcohol. Paper is the most common base material, and properties discussed apply to paper base laminates bonded with phenolic, urea, or melamine varnishes.

The properties necessary for any varnish to be useful in conventional laminating are stability of at least 1 month at 25 °C. at a minimum solids of 50% and at viscosity of less than 10 poise at 25 °C., absence of excessive odor or toxicity, reasonable cure time, and relatively low cost.

Other properties will vary with the type of laminate desired. Most laminates may be classified as mechanical, electrical, punching, or decorative.

Mechanical grades are mainly for structural application and a phenolic varnish is generally used on a kraft paper base. The following properties are indicated:

1. A low inherent viscosity for good penetration and corresponding excellent dimensional stability.
2. A strong alkaline catalyst so that a short cure time and good conversion to resin solids will result.
3. The proper mole ratio for good conversion and low cost.
4. Modifications to yield a laminate without odor or dark color.

Electrical grade varnishes are also generally phenolic and laminates are made to pass rigid electrical tests. Important points in formulation and properties are:

1. Replacement of strong alkaline catalyst with ammonia or amines that are less conductive.
2. Possible use of cresols and xylenols instead of phenol.
3. Longer cure time for extended flow.

Punching grade varnishes are phenolics modified to yield laminates with better plasticity and elasticity. Usually a phenolic of the electrical type is reacted with drying oils or other special plasticizers are added. Plasticizers must have low polarity, low water solubility, low affinity for water, and compatability with the cured phenolic resin. Decorative varnishes may be phenolic, urea-melamine, or melamine. Phenolic varnishes serve well for dark colors but their light stability is not good enough for pastel colors, and melamine varnishes are widely used now for these light colors. Melamine varnishes are superior to ureas in water, heat, and abrasion resistance. These varnishes must be free of colored or color forming bodies.

The proper varnish and paper can be best transformed to the desired laminate only after a full technical discussion between the buyer and his paper and resin supplier.

Studies of Dielectric Properties of Chemical Pulps. III. Dielectric Properties of Cellulose, Charles R. Calkins

A test capacitor embodying several desirable features has been designed and constructed for use with a Schering bridge. The loss angle and dielectric constant of native cellulose has been measured at frequencies from 500 to 4000 cycles per second at temperatures from 25 to 105 °C., under conditions that assure no inaccuracy as a consequence of the presence of moisture. The observed behavior can be adequately explained if cellulose is regarded as a heterogeneous linear polymer with many polar groups.

Similar measurements with regenerated celluloses showed significant increases in both loss angle and dielectric constant as compared with native cellulose. When these celluloses are subjected to moderate pressures, these values are reduced. A possible relationship between the observed dielectric constant and amorphous cellulose content (estimated by moisture regain) was found. However, the evidence is contradictory (a presumably amorphous cellophane was comparable with native cellulose), and no definite conclusions may yet be drawn.

Pulping of Scrub Oak (*Quercus laevis*) by the Kraft Process, R. L. Harvin, G. B. Hills, Jr., C. W. Rothrock, Jr., and W. J. Nolan

Pulping characteristics of scrub oak under widely varying cooking conditions are presented. Chemical concentrations of 20, 35, and 50 grams per liter were employed at each of 12, 14, and 16% of total chemical (pounds Na_2O per 100 pounds wood). At all of these chemical conditions, cooking pressures of 100 and 115 p.s.i. gage have been studied. Cooks were blown at 1 to

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3½ hours cooking time. In all cases, sulphidity was held constant at 25%. A total of 90 cooks was required to explore the above conditions.

Cooking and chemical consumption curves are presented for each set of pulping conditions. Graphical relationships of lignin consumed vs. wood consumed and of chemical consumed vs. wood consumed are shown.

Bleach requirements of selected pulps which were within practical limits of per cent yield and per cent screenings are presented.

Physical test data were determined for a large number of pulps which were within practical yield limits. These data (burst, tear, fold, and tensile) are presented in tabular form and, in a few typical instances, are shown graphically, plotted against beating time. Results show that these pulps from scrub oak compare favorably, in strength characteristics, with similar short-fibered pulps in use commercially at the present time.

Chemical Cleaning of Black Liquor Evaporators, H. H. Walther

Essentially, chemical cleaning is the use of liquid solvents to remove undesirable deposits or coatings that reduce the efficiency or effectiveness of process equipment. The paper industry is particularly well adapted to chemical cleaning as illustrated by the use of solvents in maintaining the efficiency of black liquor evaporators. This article deals with the fundamentals of chemical cleaning and its application to paper mill equipment with emphasis on the cleaning of black liquor evaporators.

The Operation of the Multiroll Beater-Refiner in a Southern Kraft Mill, Milton R. Roberts

The introduction covers the refining process as a matter of review with attention called to the fact that beating is usually considered a different operation from a continuous refining system employing jordans, etc. Beating covers the batch method of treating stock, whereas the continuous system is of a design to treat stock on the first pass through the refining equipment. Additional engines used in series accomplish the task. It is the purpose of the paper to show from operating data and photomicrographs that it is possible to treat fiber to the same extent as jordans and similar refining equipment with greater control and savings on power and maintenance by using the multiroll beater type refiner as a continuous system.

The beater type refiner is a triple roll beater in which the stock is treated continuously. The control is maintained through pressure adjustments of the bedplates. In the conventional batch system the bedplate is stationary with a small amount of roll pressure adjustment. In the triple roll beater the bedplates are supported during operation by six cylinders having from 0 to 300 p.s.i. pressure. Pressure variations have direct bearing on the effect of treatment. The stock flow is introduced through flow spreaders in front of the first roll. This level is constant during operation and safety features are incorporated in the design to prevent damage to the rolls or bedplates in event of flow failure.

Tests conducted over a 6-month period of operation show the beater to have the effect and flexibility for which it was designed. During the period of operation no apparent signs of wear are shown on the bars and no down-time was recorded due to maintenance. The bedplates can be reversed if in time, need for such is seen. This feature is expected to allow operating time to be double that of a bedplate which would remain in the same position until completely unfit for use.

Design of the beater has incorporated an oscillating roll for the prevention of grooves in either the roll or bedplates. Tests have shown this feature to have direct bearing on freeness of the stock treated and the quality of the stock from the standpoint of bursting strength.

Data are given to substantiate the increase of quality due to the beater and data from paper machine records prior to and after beater installation show difference in quality of paper made from beater treated fiber. Photomicrographs are shown as an aid in detecting the treatment variation at different pressures of the bedplates. Micrographs of untreated and completely treated stock are submitted for comparison.

Suggested changes and the effects of those which have been made are discussed. Efficiency of the beater as designed is compared to that after changes. Study of the 6-month operating period leads the writer to believe the use of the beater for treating southern kraft stock to be effective. Further studies under different conditions are to be made and presented to the industry at a later date.

Effect of Roll Load in Beating of Southern Kraft Pulp, C. S. Walseth and C. G. Geijer

Four 2000-pound Jones-Bertrams beaters are included in the stock preparation system of No. 5 machine at the Savannah plant of Union Bag and Paper Corp. A brief description of this installation is given. In an effort to increase the refining capacity of these beaters, a study was made of the effect of increased roll load on capacity, quality, and power consumption. Variation in roll load is accomplished by means of pneumatic cylinders, and loads up to 200% of roll weight were studied. Special beater runs were arranged during the course of regular production, and stock samples taken at intervals were evaluated by freeness measurements and physical tests on TAPPI standard handsheets. The pulp was unbleached kraft with a permanganate number of about 26.

The results indicate that increase of roll load up to 200% for beating times up to 30 minutes will increase refining capacity, but for longer beating times the advantage of higher roll loads is lost.

Curves showing burst vs. power consumption at different roll loads indicate that the same degree of strength development is obtained with less power consumption as roll load is increased, except at high roll loads and long beating times.

In the high freeness range (above about 830) an increase in roll load from 125 to 200% yielded higher bursting strength at equal freeness, but at lower freeness values this trend was reversed. The relationship between burst and tear showed that some loss in tear results from increasing the roll load from 125 to 200%.

The Effect of Kraft Pulp Mill Wastes on Fish Life, Willis M. Van Horn and J. B. Anderson

A study, first sponsored by five Wisconsin kraft mills and later by the National Council for Stream Improvement, has been made of the potentially toxic substances which may be found in kraft pulp mill wastes. Toxicity tests, using sensitive species of fish and fish food organisms, indicated that sulphides, mercaptans, resin acid soaps, and sodium hydroxide constitute the greatest hazard. Methods have been devised for measuring the amount of these compounds in kraft waste waters, and data from the examination of the wastes of five typical northern kraft mills are presented. It is concluded that the amounts of potentially harmful compounds are so small that, when the wastes are diluted in the receiving stream, their concentration is brought below the point where there would be a hazard to fish and other aquatic forms.

Industrial Use of Ground Water, William F. Guyton

The U. S. Geological Survey is the primary Federal agency designated by Congress to make basic investigations of the Nation's water sources. No construction, development, or operation of water supply is involved in its work but only studies to determine the occurrence, quality, and quantity of ground and surface water. The means by which cooperation with various water users are discussed.

The quality of ground water and points for consideration in its use are outlined. Several case histories in which the availability of water was a critical problem are discussed.

Process Water and White Water Filtration with the Automatic Backwash Sand Filter, F. C. Schad

This paper describes the application of the automatic backwash sand filter in paper plants and discusses its unique working principle in considerable detail. The significant features of this filter are its ability to automatically clean its own filter bed during operation, and the fact that it can be operated continuously and at high efficiency without shut-down or change-over. Operating data from five installations are presented in slide form illustrating typical results obtained. Operational problems and their solution are also discussed.

Control of Condensate Return Line Corrosion, William A. Tanzola

The perplexing problem of condensate return line corrosion is discussed from the standpoint of the basic factors that are involved and the mechanism of the corrosion reactions. The sources of the corrosive gases, oxygen, and carbon dioxide, are outlined, and methods of removal of dissolved oxygen and reduction of carbon dioxide are presented both from the standpoint of mechanical changes that can be made to the condensate system and the external water treatment methods of the water that are possible.

Complete elimination of carbon dioxide from condensate systems is not possible, and even small concentrations of this gas in solution can produce undesirable amounts of corrosion. The use of neutralizing types of amines for control of carbon dioxide corrosion are cited. The introduction of a new approach to the control of condensate corrosion through the use of filming type amines is discussed. These materials produce an impervious film of approximately mono-molecular thickness that render the metal surfaces nonwettable and act as a barrier between the metal and corrosive condensate. This new approach to the problem has developed a more economical solution to corrosion of condensate lines. By means of the various methods of treatment presented the economical solution to most condensate corrosion problems can be achieved.

Electrolytic Coagulation, Paul G. Stephan

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electrolytic production of aluminum hydroxide floc for coagulation purposes. Slides are furnished to illustrate the various points.

The basic fundamentals, which have been recognized for many years, are described and illustrated in the simplest form consisting of two electrodes in a beaker of water with a battery for the direct current source. From this principle the developments are described. The electrolytic method of floc production is compared with the chemical method. Chemical byproducts formed in the chemical process, such as carbon dioxide and calcium sulphate are discussed. The part played by these byproducts in the lime-soda softening process is important because of the increased corrective chemicals required by them.

The use of aluminum hydroxide in the removal of silica from boiler feed waters is described. The removal of silica by absorption with aluminum hydroxide has been tried before, but the sulphates produced in the chemical method have rendered the system impractical. The electrolytic method produces the required hydroxide without soluble byproducts. This feature makes this method of cold process silica removal quite practical.

Further comparison with the chemical system includes a storage space and weight handling comparison. Only a small percentage of weight and volume is required for the electrolytic method. This comparison is represented graphically on a slide.

Cost data on two municipal installations are presented. One comparison is for a lime-soda softening plant, the other for a purification plant.

A description of the construction and operation of the modern commercial equipment is provided as the closing of this presentation. Here again, slides are used as a visual aid in the presentation for the outline of both construction and operation.

Starch and its Application in Paper Machine Coatings, Ralph W. Kerr

A general discussion is given of the physical chemistry of starch and clay colors. The viscosity of aqueous pastes of starch is due to physical association of starch molecules which form hydrated aggregates and to the solution viscosity of very large molecules. Physical association may be either the original association as it exists in the native starch granule or a reassociation of dissolved molecules.

Starch is a mixture of two structurally different types of molecules, linear and branched. The relatively larger branched molecules provide the framework of the granule and are held together by strong physical forces. The linear molecules have a relatively high solution viscosity and show very pronounced reassociative tendencies from solution.

Various procedures which are used to reduce the paste viscosity of native starch to the level where it is usable as the adhesive in high density machine coatings are outlined and compared. Acid acts to cut the starch molecules up into smaller fragments and does so by a random hydrolysis of glucoside linkages in portions of large molecules which connect the crystallite regions of the granule. Enzymes act by a hydrolysis mechanism but break the molecules into more uniform sizes if the starch granule is first dispersed by heating in water. Oxidants and other chemical modifiers create a more permanently soluble molecule but in oxidation at least, the action is usually attended by degradation of the starch molecules. In all of these, weakening of the physical bonds in the starch granules follows as a secondary effect. Minimum starch sol and color viscosities and maximum adhesive strength are obtained when the physical bonds holding starch molecules together are ruptured and when the dispersed molecules are reduced in size uniformly to a given minimum level.

A new method of modifying starch by treating it as in dextrinization procedures in the dry state after the addition of $AlCl_3.6H_2O$ is described. The action is to weaken granular structure, depolymerize the starch molecules to the level suitable for use as the adhesive in machine coatings and to alter the ratio of linear to branched polymer molecules in starch. Application of this reaction system has lead to the production of starch products of very low viscosity and high adhesive strength.

Combination of the $AlCl_3$ reaction and enzymic conversion is described for the production of high density coatings suitable for machine application.

Enzyme Conversion and Its Application to Paper Machine Coating, D. A. Hughes and W. L. Craig

Starches of high adhesive strength and relatively low viscosity are used extensively in the paper industry. Gelatinous starches possess good adhesive strength but must be treated in some manner to reduce their viscosity. Such treatment or liquefaction may be accomplished without loss of adhesive characteristics by enzyme conversion.

Enzymes are biocatalysts and their name indicates the specific reaction for which they are used. The enzyme alpha-amylase functions with amylose (starch) and attacks specific linkages reducing the starch granule into smaller physical units. This action, which greatly reduces the viscosity, is accomplished without the formation of any appreciable amounts of reducing sugars. Being organic, the catalytic action of the alpha amylase depends upon a great number of factors including temperature, pH, concentration, and the presence or absence of certain inorganic salts. To obtain maximum efficiency from the enzyme these conditions must be observed during all conversions. In most cases the optimum dictates that the conversion be carried out for 30 minutes at a temperature of 160 to 170°F. and at a pH of 6.5 to 7.5. The amount of enzyme depends upon the liquefon content thereof and upon the concentration of the starch paste to be converted. To secure uniformity each conversion is carried out in the same manner, preferably by an automatic cam controller. Inactivation is effected at the end of the conversion period by prolonged high temperatures (200°F. for 10 minutes) or by the addition of salts which destroy the enzyme's activity. Blending of this converted starch with pigments is accomplished by the same procedure as is used for any of the paper coating adhesives.

A new process has been developed in which the starch is converted in the presence of the mineral fraction. By virtue of this process, a lower adhesive to pigment ratio is possible which results in higher finish of the calendered sheet. Bonding strength is improved because of the superior initial interdispersion of the adhesive and pigment.

Enzyme converted starches are particularly adaptable to machine coatings because they afford maximum flexibility of the finished products' physical properties. These properties can be adjusted with relative ease in cases of subsequent machine or furnish variation. Instrumentation required for proper conversion is slight and its cost is soon balanced by the saving in raw material cost involved in an enzyme conversion process.

A method for preparing water-resistant starch coatings by the Use of Antimony Salts, Lawrence Gussman, N. M. Frisch, and F. J. Sweeney

A new method for insolubilizing starch base paper coating colors is discussed.

An antimony salt, potassium pyro antimonate ($K_2H_2Sb_2O_7$) is blended with the regular components of a starch-clay coating color, applied on regular coating equipment, and dried at paper machine drying temperatures to produce a coated paper with good wet rub properties.

The theory of the chemistry of the reaction between starch and the antimony salts is discussed, and the best type of paper coating starch for use with this process is indicated.

Formulations for coating colors for high and low solids coating are given. The effect of pigments, plasticizers, drying-time, drying temperature, and pH on the antimony starch reaction are discussed in some detail.

The major advantage of the process over existing insolubilizing methods, the fact that pH adjustment is unnecessary, is brought out. The antimony starch reaction is most effective in the 7.0 to 7.8 pH range and that pH range coincides with maximum clay color fluidities. Since most printing processes are most effective on coated paper with coatings in that pH range, this factor aids printing and ink drying. The insolubilizing effect is evident immediately after the coating and drying process.

Drying time and drying temperature are the critical factors in the efficiency of the process and several charts are presented showing the wet rub of the coating in terms of drying temperatures and time.

Shelf life of the finished coating color is shown to be good and chemicals for varying the viscosity over a wide range are discussed.

The use of potassium pyro antimonate as insolubilizing agent raises the Dennison wax test over the wax of the same color without the antimony salt.

Several forms of the antimony salt are available: dry, white powders, and stable, water-thin, straw-colored 40% solids solutions.

Other uses of the starch-antimony reaction are indicated including application for insulation and wallboard coating, particularly where five retardent coatings are desired. Other fields where experimental work is in progress are wet-strength papers, asbestos paper, and wall paper.

The Rheology of Paper Coatings, William R. Willets

The importance of the rheological characteristics of coating colors, especially in view of the modern high speed printing techniques of application, is discussed. The complexity of coating color systems is described. While no presently available viscometer simulates the high shearing effects experienced in practice, tests should be made with a multipoint viscometer so as to give some indication of thixotropic or dilatant characteristics as well as of apparent viscosity. Certain factors affecting the rheological properties of coating colors were investigated using such a technique. It was found that there was not necessarily a relationship between the rheological properties of the slip and the final coating color. A very slight difference in the total solids content of coating colors resulted not only in marked changes in

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apparent viscosity but also in thixotropic characteristics, but the changes resulting from dilution varied with different colors. Coating colors behaved differently on storage some becoming less viscous and some developing more body, the effect evidently depending on such factors as composition, dispersants, pH, and total solids. The use of dispersing agents was very critical and it was apparent that an excess would result in increased viscosity as would the use of too little.

The optimum amount to be used varied with different compositions. Dispersants were found to affect the storage stability as well as the rheological characteristics of the colors as made. While no general rule applicable to all types of coating colors, could be derived from this work, the principles and techniques involved could be applied to a specific, color to be used in a definite application technique.

Casein Adhesives in Roll Coating, J. Wilson Smith, Richard T. Trelfa, and Harris O. Ware

High-quality coated paper, normally associated with casein adhesives, can be easily prepared on roll coating equipment. Satisfactory techniques for applying casein colors to paper on this type of equipment were first developed in the laboratory, and subsequent experience has proved that these procedures are adaptable to commercial machines.

The laboratory phase of this development was performed with an experimental machine-coating unit and the Hercules Hi-Shear Viscometer. Using this equipment, it was found that the flow properties of most colors governed their operability on the machine. Unmodified casein colors have high viscosity and pronounced dilatant tendencies, precluding production of acceptable coatings. These properties can be corrected by incorporating proper rheology-modifying agents, such as sodium sesquisilicate, into the color. With the sesquisilicate modification, some colors have satisfactory operating characteristics up to 65% solids.

Two mixing procedures are recommended. In one, dry casein is added to a pigment slip and solubilized in the presence of the pigment. In the other, a casein solution is prepared first, and then the dry pigment is added to the solution. Either process can be used with sigma-blade mixers, but only the former is recommended with paddle-agitated mixing tanks.

Paper from casein colors modified with sesquisilicate can be hardened by treating with formaldehyde solution or vapor.

The Reverse Roll Principle of Coating, Geoffrey Broughton, Lawrence W. Egan and Robert C. Sturken

The reverse roll method of coating is described and its advantages mentioned. In the present study the coverages obtained on a 10-inch wide laboratory reverse roll coater were measured for a glue solution (Newtonian), a vinyl resin in organic solvent (Newtonian), a clay-casein coating color (plastic), a vinyl resin in organic solvent (pseudoplastic) and an aqueous dispersion of vinyl resin (thixotropic). The results are presented for different casting roll-backing roll speed ratios, nip clearances and operating speeds. In general, the wet thickness (**t**) applied to the web appears proportional to the metering roll clearance (**D**) and the casting roll-backing roll speed ratio (**R**) and is independent of web speed as long as this ratio remains constant. The coverage can be predicted with a fair degree of accuracy by the relation $t = kDR$ where **k** is a constant. For aqueous solutions with the particular metering roll-casting roll speed ratio used (0.33), **k** had a value of about 0.5. The value of **k** is affected significantly by the metering roll-casting roll speed ratio, increasing as this variable decreases. Below a certain critical value of **R**, in no case found to be greater than one, the coating becomes nonuniform.

Preparation and Testing of Mold-Resistant Wrapping Papers, Louis C. Barail

The author first gives a few examples of industrial cases where the necessity of processing pulp and paper with mildewproofing compounds, was plainly evidenced by expensive damages which occurred not only to the paper itself, but also to the goods the wrapper was supposed to protect. For this reason, the paper industry has for quite some time been aware of the importance of imparting to wrapping papers a resistance to bacteria and fungi. The benefits of such a treatment, even if only temporary, cannot be denied.

A great number of fungicides can be incorporated in pulp or paper. They are of various types: some are water soluble, some are only soluble in organic solvents, others are of the plastic type.

The method of impregnation varies according to the chemical and physical characteristics. Some are more suitable for the incorporation in pulp, some others give best results when applied on the finished paper. The finished paper can be processed by dipping, soaking, spraying, painting, or laminating.

In the second part of the paper the testing methods are described. It is necessary to test mildew resistant pulp and paper for performance against various types of fungi and other microorganisms, but other tests are also very important. For instance, the processing should not impart any undesirable odor or taste to the wrapper since such odor or taste would be readily transmitted to the goods wrapped in it. Such paper should not be toxic as it could transmit its toxic qualities to foods or other materials by contact. Continuous handling of treated wrappers with bare hands by employees in shipping departments should not cause the slightest skin irritation.

Finally, the fungicides used in the treatment of wrappers should not change the normal color or texture of the paper, nor be susceptible to chemical changes due, for instance, to oxidation, to the action of light, cold, or heat which would alter the normal color, feel, or appearance of the wrapper.

The author describes as a conclusion some of the satisfactory results that can be obtained by treating pulp and paper with the best fungicides now on the market. This puts at the disposal of the paper industry sanitary wrappers with a lasting protection against bacteria and fungi, and free from undesirable odor or taste.

Performance of Paper Machine Wet Felts. 1. Preliminary Microscopic Observations of the Effect of Microorganisms on the Plugging of Felts, Stanley J. Buckman

A method is described for embedding specimens of paper machine wet felts which is an adaptation of a similar method employed for textiles. The felt specimens were embedded within one hour after removal from the paper machine, or were refrigerated until embedded, to prevent any significant additional growth of microorganisms. The only treatment of the felt specimens prior to embedding consisted of removal of excess water by pressing the specimens between pieces of blotting paper. Deposits in the used wet felts were preserved in the state in which they existed at the time of removal from the paper machines by impregnation of the specimens with a low viscosity solution of methyl methacrylate monomer, plasticizer, and catalyst followed by heating at 53°C. to polymerize the resin. Sections 30 mu in thickness were prepared for microscopic examination with a sliding microtome. Unstained sections were mounted directly in Canada balsam and safranin stained sections were mounted in the same medium after a minimum of preparatory treatment. Comparison of unstained and stained sections showed the deposits in the felts were not significantly disturbed by the staining procedure which aided in differentiation. Sections from used wet felts employed during the production of newsprint, kraft, and fine papers showed the presence of masses of capsulated bacteria which filled the spaces between the felt fibers to varying degrees. Photomicrographs of a number of sections are presented. The study is being extended to include a large number of used wet felts which have been employed for the production of different kinds of paper under the range of conditions encountered in the paper industry.

Some Further Observations on *Penicillium Roqueforti* Thom, John W. Appling, Stanley J. Buckman, and Conan D. Cash

An unusually interesting case of inhibition of mold growth under laboratory conditions was noted in groundwood pulp treated with different amounts of a 10% solution of phenylmercuric acetate. Pulp specimens given the lowest treatment were essentially free of mold growth when incubated in Mason jars while mold growth occurred to an appreciable extent on pulp specimens given three higher treatments with the same toxicant. Antibiosis was suspected as the explanation for the inhibition of mold growth on the pulp given the lowest treatment. The antagonistic organisms were believed to have been inhibited by the higher concentrations of toxicant thus allowing the mold to grow. The mold present was primarily *Penicillium roqueforti* and the authors had previously demonstrated the high resistance of this organism to phenylmercuric acetate. Isolations from the pulp given the lowest amount of treatment confirmed the presence of a rod-shaped, chromogenic, Gram-negative, nonspore-forming bacterium which showed marked antagonism toward *Penicillium roqueforti* under various conditions of growth, such as in malt agar medium and in groundwood pulp to which maltose and sodium nitrate had been added. As previously reported by the authors, limited growth of *Penicillium roqueforti* apparently does not appreciably affect the usefulness of groundwood pulp. However, this mold organism seems to be widely distributed and the observed results thus add to the increasing amount of information available on biological competition between members of the microflora of pulp and paper mills.

Further Studies on the Lethal Effect of Drier Roll Temperature Upon Bacteria in Paperboard, B. F. Shema

It has been shown that a heat-resistant strain of *Escherichia coli* (Frank) is killed in paperboard during the drying process. The experimental data collected show that the heat of the drier rolls is sufficient to kill all the coliform bacteria present, regardless of their position in the sheet. The total bacterial count of the wet web was reduced by 94.3%.

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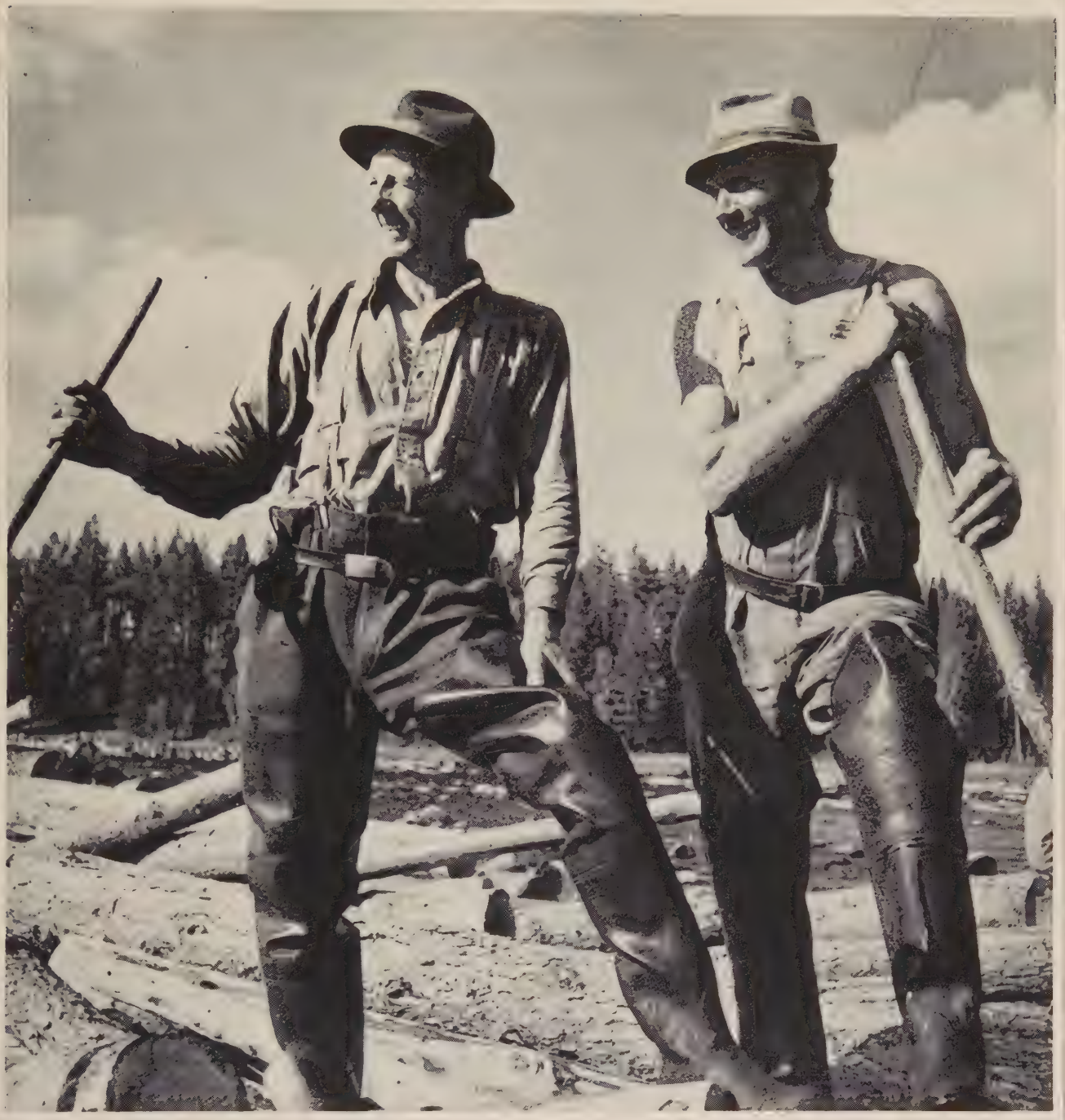

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Slime Acclimatization, Paul A. Sartoretto

Biological data is presented comparing the effectiveness of chlorinated phenols, mercurials, and mixtures thereof against slime cultures of mixed organisms taken from slime boards of paper mills. The penicillin cup method shows strikingly variable performance of slimicides against slime samples gathered from different sources, substantiating the concept of slime acclimatization. *Aerobacter arogenes*, the most prevalent organism in slime, can not be relied upon as a comparison standard for testing the effectiveness of slimicides.

Slime Measurements, L. A. McKeown and J. H. Bardsley

The surface condition of strategic sections in a mill system is an important indication of how well slime is being inhibited from growth on these surfaces. Slime measuring units using wood panels have been used for this purpose now for some time. These wood panels become infected with bacteria and do not necessarily measure the slime forming ability of the whitewater or stock. The influence of this infection is corrected by moist heat sterilization of the wood panel. Concrete panels have been tested and may offer some advantage. The physical characteristics of the panel slime growth are more important than the weight.

The Picking of Paper and Its Relation to Ink Tack, Andries Voet and Claude F. Geffken

The phenomenon of ink tack has been analyzed previously by the authors. It was found that the process of film separation must be considered as being of an impact nature. Thus, not the force, but the energy of film separation appears to be the dominant factor in ink tack.

A simple, rolling cylinder tackmeter had been described allowing the accurate determination of the energy of film separation. It was found that the tack energy density, defined as the tack energy per unit of volume of ink transferred, is independent of the nature of the surface and is proportional to the rate of film separation as well as proportional to the plastic viscosity of the ink raised to the power 1.5.

Evidence had been presented to indicate that rapid film separation does not occur primarily by viscous flow, but by a rupture, in a solid pattern, as a result of the fact that in the exceedingly small period of time in which film separation occurs the flow response to stress is overshadowed by elastic responses of the liquid to stress.

The rolling cylinder tackmeter has now been used to determine the minimum energy density necessary to cause rupture of the paper surface by the ink. This quantity, indicated as the energy density of rupture, has been measured for a number of papers by means of various inks in different film thicknesses at varying rates of separation.

It was found that the energy density of rupture is independent of the thickness of the ink film and characteristic of the paper at a given temperature and humidity.

It could be shown that rupture will occur in a paper when the tack energy density connected with the film separation exceeds the rupture energy density of the paper. Mathematical relations have been derived which allow a prediction of the maximum tolerated ink viscosity and web speed which does not cause paper rupture, from the rupture energy density of the paper. This method thus predicts paper behavior on the press and may prove to have an important practical value.

Theoretical considerations show that the conception of paper rupture, as caused by a break of the plate-ink-paper "sandwich" at its weakest spot, is quite incorrect. These views could be corroborated by experimental evidence.

Visualizing film separation as caused by rapid transvérsal vibrations in the ink film, induced by the brief impulsive stresses resulting from the roller impact, it appears that rupture of the paper only occurs at a highly vibrationally involved paper-ink interface.

New Inks for the Graphic Arts, George Cramer

Because of the demand for better printing it has been necessary for the ink industry to revolutionize its formulations. Increased printed speed is a constant demand.

Heat set inks, moisture set inks, and inks in which various plastics and resins have been incorporated have been developed. This makes it necessary for continued research on paper so that it will take these new inks and give a better printed product.

The Evaluation of Coated Paper Surfaces for Printing Ink Absorption, Andries Voet and John S. Brand

A smear of a testing ink comprising a vehicle soluble dye is applied to a coated stock. Parts of the stain are removed after increasing periods of time leaving stains of increasing intensity causing a progressive decrease in brightness of the paper surface. Plotting the logarithm of the photo-electrically determined brightness of the stained spots against the logarithm of the elapsed time, a linear relationship is obtained. The slope of the line, taken with a standard testing ink under standardized condition of temperature, humidity, and film thickness, is a direct numerical indication of the ink absorbency of the coated stock.

Safety Papers—A Review of Theory and Practice, Francis L. Simons

The whole field of safety paper use and manufacture is reviewed under three main headings:—general theory of protection against document frauds, past and present manufacturing practice as indicated by the patent literature, and a classified bibliography of domestic and foreign patents.

The discussion of theory includes definitions and distinctions between safety papers and banknote papers. It also includes a systematic review of the various types of document fraud and the qualities required in safety and banknote papers to combat these risks. Attention is called to the fact that a great deal of unnecessary mystery surrounds the subject and that this has resulted in many popular misconceptions.

The discussion of manufacturing practice is in the form of an historical review of important patents together with comments from the author's own experience where present-day methods are concerned.

The bibliography of over 300 patents is subdivided into several classes for convenient use and each entry is accompanied by a very brief abstract.

A Stain for Use in the Microscopy of Beaten Fibers, Francis L. Simons

The study of papermaking fibers during the beating cycle is made much more convenient by the stain described. Two direct dyes are used, a blue of Color Index No. 518 and an orange of Color Index No. 621. They are applied in water solution at 60 °C. to fibers mounted on the microscope slide in the usual manner. Unbeaten fibers are colored blue whereas beaten fibers are dyed wholly or partly orange depending on the degree of beating.

Fibrils are stained orange and broken or brused spots on the fibers are also orange while the remainder of the fiber is blue. A "broomed" end stains orange with gradual transition to the blue of the rest of the fiber.

The effects of beating can therefore be followed closely and an over-all estimate of the degree of beating made from the relative amount of orange coloration present. The method is equally applicable to slush pulp or to defibered samples of finished paper. It is also relatively independent of cooking and bleaching conditions and gives the same results with such widely differing fibers as bleached cotton and unbleached sulphite.

The Role of the Slice in Sheet Formation for Light Weight Papers, W. O. Boylon

The role of the slice in sheet formation for lightweight papers involves, in addition to the slice proper, the type of approach flow to the slice and the setup of the fourdrinier following the slice affecting the manner in which the slice delivers stock onto the wire are (1) the uniformity of mixture of fiber and water in the approach flow, and (2) turbulence and currents directly behind the slice. Some of the operational difficulties traceable to poor slice discharge are discussed.

The effects of breaking, refining, size of wire pit, manner of admitting refined stock, dirt removal equipment, and stock piping layouts on the uniformity of mixture are discussed. The requirements for an inlet or stock distributor are enumerated and various types are described.

The desirable features of a high-speed slice and head box are listed, followed by a detailed description of five different types—including the new Beloit air loaded head box. Sketches are used to illustrate actual flow velocities and directions through each of these head boxes.

The effect of fourdrinier setup on sheet formation is covered with special emphasis on the part played by aprons, forming boards, dandy type table rolls, deflectors, etc. The degree of sheet formation at various points along the fourdrinier is discussed; and it is pointed out that formation of lightweight papers may be perfect at the slice, but poor going onto the press section due to defects in fourdrinier arrangement or use.

In conclusion, the slice is all too frequently blamed for poor formation which actually can be traced to nonuniform stock mixtures delivered to the head box, turbulent currents directly behind the slice, or poor fourdrinier arrangements.

The Ideal Slice, S. A. Staege

The flat angle slice is illustrated and several of its advantages emphasized. The position of upper and lower slice lips, with relation to the breast roll, is discussed and the relation of the lower slice lip with the wire is analyzed.

Totally enclosed pressure inlets and slices are illustrated and also a very short open head box arrangement is shown, with a discussion of its advantages over a long head box with numerous baffles.

It is pointed out that there must be uniform approach flow of

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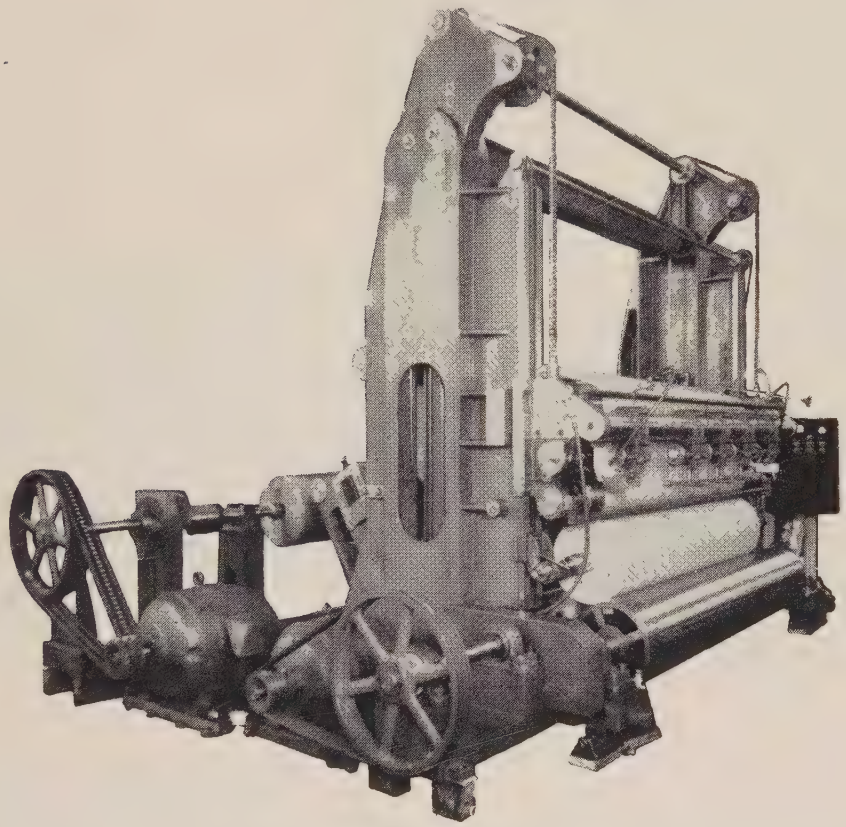

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the stock to the slice, if good formation and uniform weight are to be obtained.

A greater degree of fiber crossing and cross strength of the sheet is indicated as an inherent characteristic of the flat angle slice. That "jumping" at the slice, in the case of high-speed machines, is often caused by too steep an angle of the upper slice lip or incorrect positioning with the lower slice lip and breast roll is pointed out.

As a means of obtaining uniform parallel flow and fiber distribution, the hydronamic inlet is shown in connection with the close coupled flat angle slice, both for totally enclosed pressure inlets and the open head box arrangement.

Unscientific Way to Scientific Help in Packaging, C. S. Macnair

The main job of packaging is not to protect the article of commerce against the unusual accidents that it might have, but to protect it against the ordinary hazards likely to be encountered in distribution. The author follows the steps taken by a hypothetical package from its assembly to the final distribution point and indicates hazards to which it may be subjected.

Some Aspects of Container Handling in Rail Transportation, E. J. Dahill

The art and science of the manufacture and use of shipping containers and of materials handling was given much impetus during the last war and fortunately that impetus is being carried over into peace-time operations for both domestic and foreign shipments.

Practically all manufactured articles are packed in some kind of shipping container and which container shall be used, how the articles shall be packed, what shall be the number of articles in a shipping unit, what elements the article must be protected against, what will be the over-all costs of these operations and materials is definitely of much interest to all shippers.

The paper industry in 1948 produced 22,048,000 tons of paper and paperboard, of which 10,853,000 tons or 49.2% were paperboard, and of this latter tonnage 4,969,000 tons or 45.8% was fiberboard. With such a tremendous proportion of paper products going into shipping containers, the paper industry should be actively interested in developing and setting up standards of use and serviceability and how to measure these qualities.

There are many hazards encountered in handling, warehousing, and transportation and many interests are now endeavoring to determine how numerous these hazards are, their amplitude, frequency, and intensity and whether they are natural or man made.

In October, 1907, there was first published in a Railroad Tariff the requirement for a bursting strength test for fiber boxes. In 1919, the Consolidated Freight Classification included this test in Rule 41. This test is the only one dealing with the strength factors of the containers, but it does not measure nor indicate what a completely packed and closed container will withstand in normal transportation.

Some studies have indicated that a container will be "handled," in a typical carload shipment, not less than a minimum of 16 times and in an L.C.L. shipment, a minimum of 27 times. The question arises as to what is the character of these handlings according to weight, size, and character of the container.

The usual freight car, while in motion, has three movements, laterally, vertically, and longitudinally, and some measure should be had as to what would be the intensities and numbers of the shocks which a package would receive in an ordinary journey. Some factual data on this point are presented in this paper.

Continuing on the subject of "handling," how high will be the drops which a package of various weights will receive when being manually handled; what is the intensity of the vibration of a package moving on a roller conveyor, on a hand truck, an automobile truck, and in freight cars. These points, too, are covered to some extent in this paper.

A brief discussion is given on the generally accepted testing devices, the revolving drum, the Conbur Incline Test, the drop test, and the vibrator which has been developed in the last few years.

Some data are presented on the matter of relative humidities which shipments will encounter in transportation and the question is raised as to what is "waterproof" and "waterproofed" in connection with providing containers to resist these humid conditions.

Particular stress is laid on the trend now apparent of providing for performance tests of shipping containers, which are in an effort to simulate by laboratory tests the hazards which a package will receive during handling, warehousing and transportation.

Quotations are given from a very successful study made by the Eastman Kodak Co. along the above lines and reference is also made to the procedures and tests set up by the National Safe Transit Committee, in connection principally with articles of enameled steel, such as gas and electric ranges, refrigerators, etc.

The author does not attempt to answer the questions he raises in his paper but rather asks that the technical members of the paper and pulp industry think about these matters, as the interest of their industry goes beyond simply providing the fiberboard and heavy papers used in making shipping containers.

Quality Control of Corrugated Shipping Cases from a Buyer's Viewpoint, E. H. Balkema

The author outlines the testing procedure and methods used by his company to evaluate the shipping containers which they purchase. In addition to their own testing they use the services of commercial testing laboratories to check their results. On the basis of their experience the author presents a list of questions of interest to other users of shipping cases.

Penetration of Neutral Sulphite Cooking Liquors into Yellow Birch Wood, Victor J. Wirpsa and C. E. Libby

The degree of penetration of liquor into two-foot yellow birch logs when cooked with neutral sulphite liquor was determined and the influence on penetration of the following variables was investigated: (1) pre-evacuation of air from digester, (2) use of hydrostatic (artificial) pressure, (3) combinations of pre-evacuation and hydrostatic pressure, (4) chemical concentration of liquor, (5) use of wetting agents, (6) storage of logs after cooking, and (7) moisture content of logs before cooking. Tables of data and graphs showing the relative effect of these several variables are presented.

In connection with this investigation a method for the qualitative estimation of the extent of penetrating of sodium into wood was developed. Using standard quantitative methods of analysis a determination was made of the distribution of chemicals throughout the penetrated zone of seasoned yellow birch sapwood. The results of these researches have been confirmed by pilot-plant scale tests conducted in the laboratories of the New York State College of Forestry.

The Manufacture of Chemigroundwood Pulp from Hardwoods, C. E. Libby and F. W. O'Neil

A process has been developed for converting aspen, birch, beech, and maple woods into mechanical pulps which may be substituted successfully for spruce mechanical pulp in most grades of paper. It is proposed to identify this new type of wood pulp by the coined name Chemigroundwood.

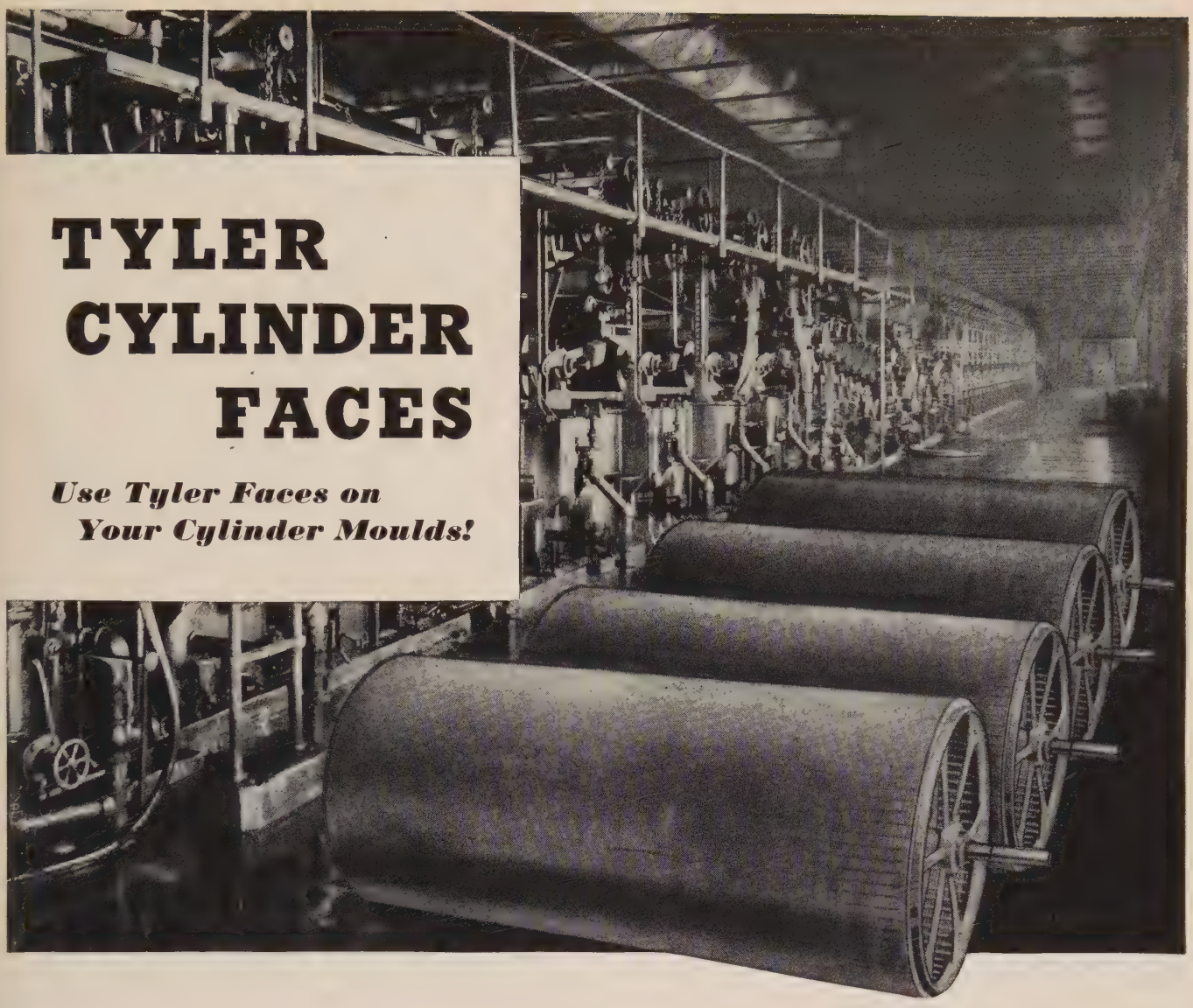
The chemigroundwood process consists of a mild chemical pretreatment of the wood in block form followed by mechanical defibering in any conventional wood pulp grinder. Chemigroundwood pulp is manufactured more successfully from hardwoods than from softwoods since the coniferous woods do not respond as favorably to this type of chemical treatment. The treated hardwood is ground with one-half to two-thirds the power and at double the production rate of spruce groundwood. The pulp itself is three to four times as strong as ordinary spruce groundwood, standing intermediate in this respect between spruce groundwood and unbleached sulphite pulp. The chemigroundwood process gives pulp yields ranging between 85 and 90% of the weight of the original wood.

Most species of hardwoods give chemigroundwood pulps which may be bleached with peroxide or calcium hypochlorite to the same final brightness as spruce pulp and at no greater cost. The high density of the principal hardwoods results in pulp yields that exceed the average yield from the conifers by at least 700 pounds per cord of wood. The value of this additional pulp is several times as great as the cost of the mild chemical pretreatments which are an essential feature of this new pulping process.

The Northeastern states have abundant resources of hardwoods that are available at relatively low cost compared to the softwoods. The ample supply of these woods, plus the tremendous advantages in quality and yield of fiber by the chemigroundwood process, presents to the paper industry of this region an unprecedented opportunity to reestablish the manufacture of wood pulp from native woods on a sound economic basis.

Effect of Bark in the Neutral Sulphite Semichemical Pulping of Aspen, Hickory, and Slash Pine, E. L. Keller

Bark-free chips and mixtures containing up to 25% bark by weight were pulped by the neutral sulphite semichemical process. With yields from the wood fiber ranging from 76 to 80%, yields of 55, 52, and 35% were obtained from the barks of quaking aspen (*Populus tremuloides*), pignut hickory (*Carya glabra*), and slash pine (*Pinus caribaea*), respectively. During the impregnation stage of the digestion, slash pine bark absorbed twice as much sodium sulphite per pound from the cooking liquor as an equal weight of the wood, while aspen bark absorbed only slightly more than the corresponding wood and hickory bark an intermediate amount. The inclusion of moderate amounts of bark required only minor changes in cooking conditions. With the exception of an increase in the folding strength of hickory pulp, the strength values of standard test sheets declined regularly with increasing amounts of bark. Folding strength was the most sensitive of the strength properties, the losses in this property being as much as 90% in some instances. Tearing resistance was the least



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affected, the maximum loss being 15%. Density of sheets containing bark was low. The properties of the hickory pulps were little affected by the presence of bark, while the aspen pulps suffered serious losses in strength and density. Slash pine bark had an intermediate effect.

Production of High-Yield Pulps from Aspen by Mild Treatments with Sodium Hydroxide, K. J. Brown and J. N. McGovern

In experiments at the U. S. Forest Products Laboratory, aspen (*Populus tremuloides*) chips were given mild treatments with sodium hydroxide solutions at atmospheric pressure and then mechanically fiberized to produce pulps in the yield range of 82 to 95%. Treatments were made with caustic solutions in concentrations of 24 and 63 grams per liter. Treating time varied from 15 minutes to 5 hours and temperature from 25 to 90°C.

The optimum treating condition from the standpoints of the treating variables, pulp yield, and pulp strength was a 2-hour treatment at 25°C. with a sodium hydroxide solution having a concentration of 25 grams per liter. Chemical consumption for this treatment was about 5.5% sodium hydroxide, based on the weight of the wood, and a pulp yield of about 91%. Pulp made under these conditions was converted into corrugating board that compared favorably with commercial hardwood semichemical corrugating board in strength properties.

Groundwood Pulping of Mixtures of White Spruce and Quaking Aspen, E. R. Schafer and A. Hyttinen

Groundwood pulping experiments were made on quaking aspen and spruce and on three mixtures of these woods. As the amount of aspen in the mixture was increased, the motor load remained constant but the grinding rate increased, energy consumption decreased, freeness increased, and strength decreased. These relationships were linear, or nearly so in most instances. The properties of mixtures of spruce and aspen groundwood pulp were, in general, the same whether the woods were ground together or ground separately under the same conditions of grinding.

Quality Improvement of Deinked Stock by Centrifugal Separators, H. P. Bailey, J. J. Forsythe, and J. P. Tomaszewski

Types of foreign matter found in present day waste paper stock have demanded improvements in removal methods to insure clean, high-quality stock for paper machine use. Experiments were run with centrifugal separators at several points of a commercial deinking system.

The study has indicated that a considerable amount of extraneous material could be removed from deinked stock which had already been screened by conventional screens. Troublesome materials such as "tacky" spots could also be removed at this point.

It was further found advantageous to replace tailing flat screens by centrifugal separators. Use of centrifugal separators reduced fiber losses, increased dirt removal, and resulted in a cleaner stock. Tacky material was also partly eliminated by this installation.

Additional investigation indicated that it should be possible to treat unscreened deinked stock with centrifugal separators and produce a pulp which would compare favorably in cleanliness and appearance with stock which had been screened with conventional screens.

Relations Between Yield and Properties of Spruce and Aspen Sulphite and Sulphite Semichemical Pulps, J. N. McGovern

Relations between the yield of pulp and its strength properties and chemical composition were determined for sulphite pulps ranging in yield from full-cooked to semichemical, using black spruce (*Picea mariana*) and quaking aspen (*Populus tremuloides*). Optimum pulp strength was obtained at yields near 50% and good strengths relative to the optimum were found at yields near 60%. Pulps made in yields of approximately 75% were weak and bulky in comparison with pulps made in lower yields for the respective species. The lignin and hemicellulose contents of the pulps increased with increasing yield and the cellulose contents decreased.

Ammonia-Base Sulphite Pulping of Hardwoods, E. F. Thode and Y. H. Lee

Drastic ammonia base acid sulphite pulping preceded by impregnation with neutral ammonium sulphite has been studied using commercially prepared mixed hardwood chips, composed of birch, beech, and maple. Variables studied were: temperature of impregnation, time of cook, temperature of cook, and per cent combined sulphur dioxide in the cooking acid. Eight indirect cooks of this nature were performed in a laboratory digester according to the following schedule: steaming, 1 hour at 237°F.; impregnation, 2 hours at 240° or 270°F.; cooking, 2 to 4 hours at 295° to 315°F., and 100 p.s.i. gage pressure. A very sharp temperature rise was used. For purposes of comparison, a conventional cook using ammonia-base sulphite cooking acid was performed on chips from the same batch. In this particular cook no steaming or neutral impregnation were employed, but the usual slow temperature rise and long cook (12 hours) at moderate temperature (275°F.), characteristic of conventional acid sulphite pulping, was used. Alpha-cellulose permanganate number, and beater performance were determined for each cook; also, bleaches were conducted on a few selected cooks.

Results show that the best set of conditions tried gives results comparable to a conventional cook in half the digester time required for such a long cook. Furthermore, the spent liquor resulting from the impregnation needed for this rapid cycle may be refortified and reused. Yields of about 45% and alpha-cellulose contents (unbleached) of up to 86% are reported. It is concluded that the relatively high diffusion velocity of the ammonium ion makes the use of this base highly attractive in the sulphite pulping of hardwoods.

Proven Methods of Screening Maximum Quantities of Quality Pulp, H. F. Schenk

The author indicates the forces and factors involved in the operation of a flat screen and suggests points which should be considered if maximum efficiency is to be obtained.

Circulation Systems and Sulphite Pulping, J. M. Wilcox

Results of a questionnaire sent to 105 sulphite pulp mills in the United States and Canada and answered by 82 mills show that a much larger percentage of production is made using circulation, both with and without external heaters. The percentage is higher for those mills which sell all or part of their pulp. Also, the percentage is higher for the mills producing the higher grades of pulp. A tabulation summarizing the results of the questionnaire is presented.

A study is made between two bleached sulphite mills, comparing operation and results using circulation with direct and indirect cooking. The need for circulation in producing high-yield pulps is stressed. Several factors affect strainer design and location, as well as proper circulating pump operating characteristics.

Use of Waste Sulphite Liquor in Concrete, E. W. Scripture, Jr.

A recent development in disposal of waste sulphite liquor is its use as a dispersing agent for portland cement to improve the properties of concrete mixes.

Calcium lignosulphonate derived from waste sulphite liquor, adsorbed by the cement particles imparting electrostatic charges and making them mutually repellent, is a specific dispersing agent for cement. Studies have been made of various physico-chemical properties of calcium lignosulphonate in view of the influences these might have on cement dispersion. Purity is of importance as the sugar content of normal liquor adversely affects cement hydration. A suitable composition is secured in the fermentation process for the production of alcohol from waste sulphite liquor. Other processes which remove the sugars from the waste sulphite liquor also provides sources of an effective cement dispersing agent. Extensive studies have been made of the colloidal characteristics of waste sulphite liquor from different sources, from different types of wood, and produced under various conditions, as these relate to the behavior of the material with portland cement.

Dispersion produces three important effects. Water trapped within particle clumps is released to become part of the mixing water, lowering water required for a given consistency. The surface area in the cement in contact with water is increased, promoting more efficient utilization. Additional air is entrained in the concrete, reducing bleeding and increasing durability. Data are presented to show what this means in relation to the workability, strength, watertightness, and durability of concrete. Calcium lignosulphonate is also extensively used to improve grinding efficiency in the manufacture of cement.

Calcium lignosulphonate from waste sulphite liquor, compared with other cement dispersing agents, has the advantage of economy since, derived from a waste, it can be used at a cost considerably less than the value of the improvement produced in the properties of concrete.

The Preparation and Properties of Resin Saturating Papers, M. P. Seidel

The conversion of eight commercial pulps into phenolic resin saturation type papers is described. Tests were made on the pulp and the paper. Machine conditions under which the papers were made are described.

The Mechanical Properties of Paper-Base Laminates, M. P. Seidel

Phenolic resen bonded laminates were made using saturation type papers of eight different commercial pulp stocks. These papers were of comparable thickness, high porosity, low density, and minimum grain. The properties studied were tensile, flexural, impact, and bond strengths. Significant differences due to fiber orientation, length, and refining were observed.

TAPPI DIVISIONS AND COMMITTEES

Recent Reports of Activities

Report of the Tellers Committee

John H. Doherty of the Union Bag & Paper Co. and Chairman of the Tellers Committee reported on the results of the mail ballot for election of Association officers and executive committeemen. His associates on the committee were V. L. Tipka, News Print Service Bureau and Kurt Weil, Roderick O'Donoghue Co. The officers elected were:

President: Albert E. Bachmann, Missisquoi Corp., Sheldon Springs, Vt.
Vice-President: Kenneth P. Geohegan Howard Paper Mills, Inc., Dayton, Ohio.
Executive Committeemen (to serve three years)
Karl O. Elderkin, Crossett Paper Mills, Crossett, Ark.
Milton Jacobs, Chas. T. Main, Inc., Boston, Mass.
Ralph W. Kumler, American Cyanamid Co., New York, N. Y.
George E. Shipman, Donnacona Paper Co., Donnacona, P. Q.
Executive Committeeman (to serve one year)
Richard P. Price, Hammermill Paper Co., Erie, Pa.

Report of Engineering Division

Organization

Following the Boston Engineering Conference three committee chairmen of the Engineering Division resigned.

A. E. Montgomery, Chairman of the Drying and Ventilating Committee, tended his resignation and he was replaced by M. L. Barker of Beckett Paper Co., with G. H. Young of Midwest-Fulton Machine Co. as Secretary.

Geo. R. Wadleigh, Chairman of the Materials Handling Committee, tended his resignation and he was replaced by A. P. Schnyder of Ebasco Services, Inc., with H. F. R. Weber of Link-Belt Co. as Secretary.

Wm. J. MacIntosh, Jr., Chairman of Maintenance and Materials Committee, tended his resignation and he was replaced by M. S. Fogerty of Sutherland Paper Co. with R. T. Barnes, Jr., of International Nickel Co. as Secretary. (*Ed. Note:* Mr. Fogerty died suddenly in February.)

Committees

At the February, 1949 meeting, two new committees of the Engineering Division were formed. The Electrical Engineering Committee with A. S. Goodrich of Hammermill Paper Co. as Chairman and Geo. W. Knapp of General Electric Co. as Secretary. The other one was the Data Sheet Committee with Henry Perry of the *Paper Trade Journal* as Chairman. Both these committees are doing outstanding work for the Engineering Division.

Last spring the Chemical Engineers in TAPPI requested that they be transferred to the Engineering Division. We are very glad to welcome these Chemical Engineers into this Engineering Division and have set up this committee with J. R. Lientz of Union Bag as Chairman. Mr. Lientz has done an excellent job in organizing his committee and has arranged a three-hour paper presentation session for the February, 1950 New York meeting. We thought it advisable to have this Chemical Engineering paper presentation session at the February meeting rather than at the Engineering Conference in the Fall.

At the 1949 Engineering Conference, due to the outstanding work being done by the Hydraulics Subcommittee, we considered it advisable to advance this group to full committee status. This action was taken and this new Hydraulics Committee set up with K. J. Mackenzie of Eastman Kodak as Chairman.

The Engineering Division now consists of ten committees and we feel we have a very strong committee organization. This committee setup and the members of the various committees are given in the 1950 TAPPI Year Book.

You will note that practically all the committees of the Engineering Division have Secretaries. This arrangement has worked out very well. In most cases the Committee Chairman is a pulp or paper mill man and the Secretary is a manufacturer's representative.

Committee Projects

The various projects now being worked on by the Engineering Division committees are all listed in TAPPI Year Book and no further comment is necessary.

In most cases these committees are working actively on these projects and we expect to have some very valuable data worked up for the industry.

Fourth Engineering Conference—Boston

From all reports this was another outstanding Engineering Conference. The papers were good, the sessions were well attended and a large number of the members participated in the discussion periods. The total registration at this Conference was about 500.

The sponsored cocktail party and dinner was held on Tuesday evening. This affair was sponsored by about 20 manufacturers from the New England area. The sponsoring was on a voluntary basis and with such a large number of representatives taking part, the cost was not a burden to any one company. This type of sponsorship proved very successful and we plan on following a similar procedure at the next Engineering Conference.

The mill visits on the fourth day of the Conference were well attended and considered very much worth while by all the groups. The plants visited were: Bird Machine Co., The Foxboro Co., Riley Stoker Co., Rice Barton Corp., Lodding Engineering Corp., Norton Co., and General Electric Co. at Lynn, Mass.

We were very glad to have as our guest at the Boston Conference, A. E. Bachmann, President of TAPPI. We were also pleased to have the Paper Manufacturing Committee meet with us at this Conference.

Fifth Engineering Conference—Cincinnati

This Conference has been scheduled for October 2–5, 1950 inclusive, at the Netherlands Plaza Hotel in Cincinnati. We expect to have a larger attendance here than at the Boston meeting due to the fact that Cincinnati is more centrally located.

Most of the committees have tentative plans for their part in this Cincinnati meeting. It looks as if all the papers for this Conference will be available by June 1 for publication ahead of time in *Tappi* magazine.

February, 1950, New York Meeting

We had a combined meeting of all the committees in the Engineering Division on Monday afternoon, February 20, at the Commodore Hotel in New York City as scheduled on the program. This consisted of an open discussion session covering our committee activities, plans for the Cincinnati Conference, and the selection of a place for the 1951 Conference.

On Tuesday, February 21, at 2:00 p.m., we had three excellent papers which were presented under the sponsorship of the Chemical Engineering Committee of the Engineering Division with J. R. Lientz as Chairman. It is the general feeling that this Chemical Engineering activity should be confined to the February Meeting since so many chemists and chemical engineers are in attendance, rather than at the Fall Engineering Conference.

Some thought is being given to having a short regular session and a discussion period for this Chemical Engineering group at our Fall Conference so that they will more fully realize that they are part of the Engineering Division.

1951 Engineering Conference

Considerable thought has been given as to where this conference should be held. It is the consensus of opinion of the Engineering group that we should go to the South for this 1951 meeting. A number of locations in the South have been suggested, such as Chattanooga, Birmingham, Atlanta, Savannah, Macon, and New Orleans.

GEORGE H. PRINGLE, *General Chairman*

Research Appropriations Committee Report

One research grant, amounting to $1000 was made during 1949 to the Fundamental Research Committee for a project on the structure of lignin. This research was initiated at Bucknell University, under the direction of Dr. Manning Smith. The project has three distinct phases:

1. Development of a new method of degrading lignin.
2. Condensation of lignin with p-chlorobenzaldehyde.
3. Methylation of lignin of low methoxyl content.

This program is designed to prove or disprove the lignin theory of Russell (TAPPI Monograph No. 6, pages 220–234). Considerable progress has been made towards this objective, as reported in Progress Report No. 3, January 1, 1950, from Bucknell University. Dr. Lewis, chairman of the Fundamental Research Committee, has stated that this project will probably continue through the coming summer on the 1949 research grant.

It should be clearly understood that the research grant described in the previous paragraph was not processed by the Research Appropriations Committee, nor was it submitted to the Committee for consideration. The grant was approved by the Executive Committee of TAPPI at its June 29, 1949 meeting.

At the 1949 Annual Meeting of this Association, W. F. Gillespie included in his Presidential address a plea for TAPPI to foster original investigations and adequately finance them. "Over a ten-year period, appropriations aggregating less than $16,000 have been expended on 15 projects. For an association with approximately 70 committees this is not enough." Mr. Gillespie attributed this relative inactivity to two reasons:

1. The committees are not actively pushing the projects which they state as objectives.

2. The executive committee has taken a conservative view relative to some of the requests for research grants.

During the past two or three years considerable confusion has arisen concerning the purpose of TAPPI research grants. The reason for this confusion may be due to the fact that very few committees have applied for financial aid and, therefore, many executive committeemen are unfamiliar with the procedure to be followed. A restatement of the "Regulations Governing Research Appropriations" on page 52 of the "1949 Year Book" may help to clarify this situation.

1. The purpose of research grants is to give financial aid to the projects of association committees.

2. Application for research grants must originate in a committee and can be made by any committee requiring financial assistance in its work.

3. The application must be submitted to the respective division chairman for approval. The request then can be submitted to the Research Appropriations Committee.

4. The type of information to be contained in a committee request for financial aid is given on page 52 in the "1949 Year Book."

It should be the responsibility of the Division Chairman, to whom the request is submitted for approval, to determine if the grant is intended for a bona fide project of the committee concerned and if the complete information concerning the project is included in the request, before he approves it and sends it to the Research Appropriations Committee. The latter committee, upon receipt of a request for a research grant, will determine if the project merits the financial support of the Association and make its recommendation to the Executive Committee. Furthermore, the Research Appropriations Committee administers the appropriations granted, maintains contact with the committees concerned, and arranges for the publication of the results of the research.

The Committee recommends that the chairmen of all Association committees should be made aware of the fact that financial aid is available for their projects, subject to the approval of the respective Division Chairman, and that request for research grants must be made in accordance with prescribed regulations.

JOHN L. PARSONS, *Chairman*

Report of Standards Committee for 1949

Since 167 of the 184 standards and suggested methods now in the TAPPI looseleaf manual have to do with testing methods, it naturally follows that the main source of new and revised standards is the committees in the Testing Division. The changes in chairmanship of six of these committees in the past year or so and committee reorganizations have therefore resulted in a slowing of production. Nevertheless, the committees of the Testing Division, as well as other committees, now have a considerable number of projects under active consideration.

New and Revised Standards

Two new tentative standards were approved during the year and submitted to the Secretary for publication:

E 603 s-49. Specification for Chemical Composition of Process Water for Manufacture of Soda and Sulphate Pulps (*8*)
T 635 m-49. Analysis of Tall Oil Skimmings (*1*)

Revisions of six tentative standards were approved and published:

O 406 p-49. Standard Terms Used in the Sulphite Pulping Process (*2*)
T 7 p-49. Weight-Volume Measurements of Pulpwood and Chips (*3*)
T 228 m-49. Bacteriological Examination of Pulp (*4*)
T 449 m-49. Bacteriological Examination of Paper and Paperboard (*5*)
T 456 m-49. Wet Tensile Breaking Strength of Paper and Paperboard (*6*)
T 631 m-49. Bacteriological Examination of Process Water (*7*)

Five tentative standards were recommended for advance-

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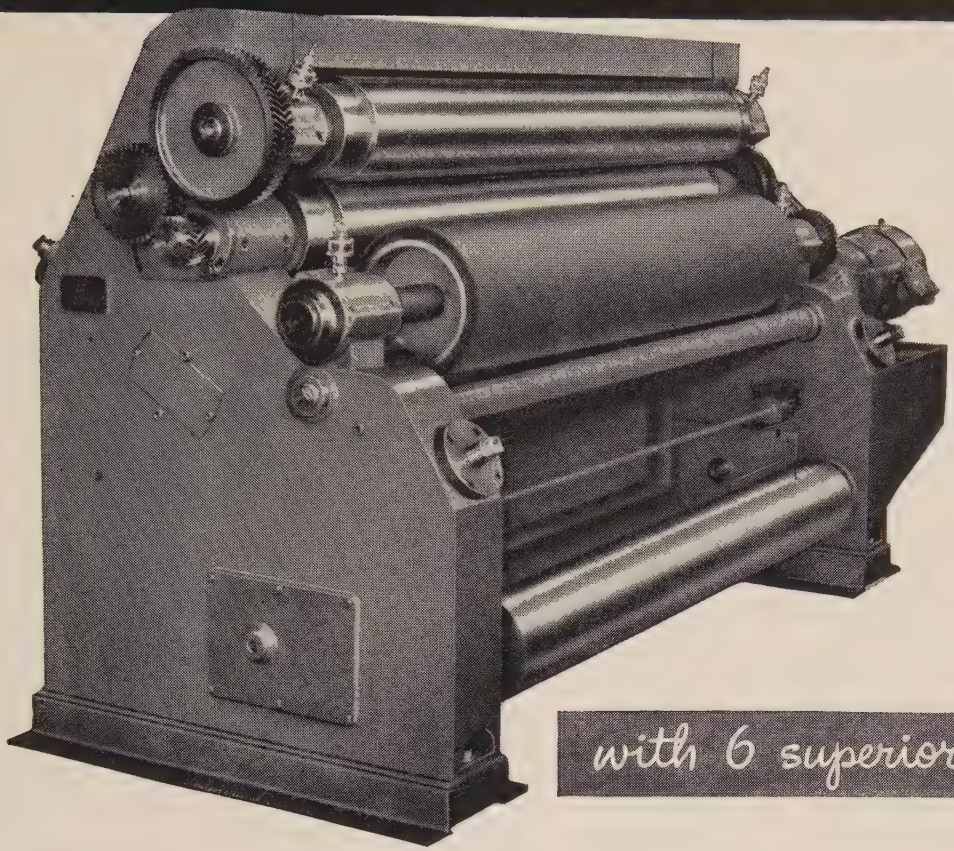

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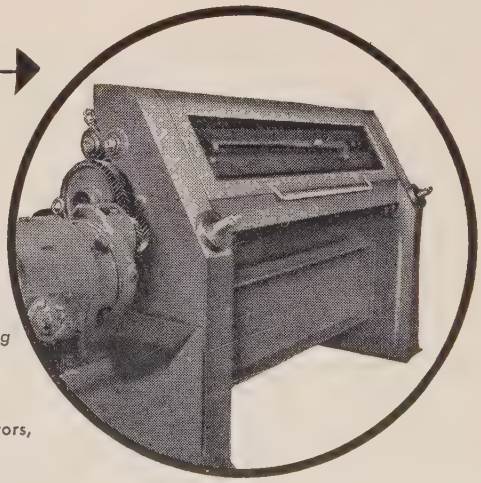

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ment to official standards and will be submitted to vote of the TAPPI membership:

T 14 m-47. Dirt in Wood Chips
T 16 m-46. Sieve Analysis of Pulpwood Chips
T 475 m-47. Bleeding Resistance of Asphalted Paper at Elevated Temperature
T 477 m-46. Blocking Resistance of Paper and Flexible Materials
T 633 m-47. Preparation of Magnesium Oxide Standard for Spectral Reflectance

It was decided to postpone recommending the advancement of four other tentative standards.

One suggested method was advanced to a tentative standard:

T 476 sm-46. Abrasive Loss of Paper and Paperboard

The two tentative standards recommended in 1948 for advancement to official standards were approved by letter ballot of the TAPPI membership in April, 1949. They will be included in the forthcoming mailing, namely:

E 203 p-49. Paper Machine Drying Rate
T 460 m-49. Air Resistance of Paper

Contents of Book of Standards

The following are now being set up in print for the looseleaf manual and will be mailed early in 1950:

2 new tentative standards
2 tentative standards advanced to official
1 suggested method advanced to tentative standard
6 revised standards
8 corrected standards

When the above are included the manual will comprise the following:

	Tentative	*Official*	*Total*
Standard Recommended Practices	2	11	13
Standard Specifications	4	1	5
Standard Testing Methods	42	110	152
Suggested Methods	...	...	16
	48	122	186

16-Year Summary

Since the organization of the Standards Committee in 1933 it has approved and issued the following:

New tentative standards	82
New suggested methods	30
Suggested methods advanced to tentative standards	12
Tentative standards advanced to official	94
Revisions	82
Corrected standards	218
	518

Annual Review of Standards

One of the most difficult problems in regard to standards is to keep them up to date. It is perhaps natural that a committee should prefer to work on a new method rather than on "old stuff." Periodic reviewing of TAPPI standards, however, by the committees having jurisdiction over them is just as important as developing new ones and is a much better policy than to wait for serious criticisms from the outside. There are now some 70 standards which have not been critically reviewed since 1940, and 48 of these not since 1935. Probably many of these are OK; certainly some of them need revision. At any rate, all of them need reviewing. Many of the oldest ones are under the jurisdiction of the Nonfibrous Materials Testing Committee (19) and the Chemical Methods Committee (22).

It is suggested that each committee chairman be supplied with a list of standards under the jurisdiction of his committee and that *each year* he arrange for a critical review of all such standards which have not been issued, revised or reapproved within ten years. After such review the committee should either reapprove the standard or authorize an active project for its revision and notify the Standards Committee to that effect.

LITERATURE CITED

1. *Tappi* 32, No. 11:98A (November, 1949).
2. *Tappi* 32, No. 7:52A (July, 1949).
3. *Tappi* 32, No. 8:61A (August, 1949).
4. *Tappi* 32, No. 11:92A (November, 1949).
5. *Tappi* 32, No. 11:88A (November, 1949).
6. *Tappi*, 32, No. 8:60A (August, 1949).
7. *Tappi* 32, No. 11:96A (November, 1949).
8. *Tappi* 32, No. 12:64A (December, 1949).

ROGER C. GRIFFIN, *Chairman*
TAPPI *Standards Committee*

APPENDIX

Assignment of Standards

As of the end of 1949, the jurisdiction of the various committees over standards is as follows, those standards which have not been revised or reapproved since 1940 being *italicized*

Acid Pulping (1)
O 406 p
Alkaline Pulping (4)
O 400 p, O 401 p, O 402 p, O 404 p
Chemical Products (1)
O 405 p
Chemical Methods (50)
T 1 m, T 2 m, *T 3 m, T 4 m, T 5 m, T 6 m*, T 9 m, T 12 m, T 13 m, T 15 m, T 17 m, T 201 m, T 202 m, *T 203 m, T 204 m, T 206 m, T 207 m, T 208 m*, T 209 m, *T 211 m, T 212 m*, T 214 m T 215 m, T 222 m, T 223 m, T 229 m, T 230 sm, *T 405 m*, T 406 m, T 407 m, T 408 m, T 412 m, *T 413 m, T 415 m, T 417 m*, T 418 m, *T 419 m*, T 421 m, *T 428 m*, T 429 m, *T 434 m*, T 435 m, *T 436 m, T 438 m, T 439 m*, T 444 m, T 450 m, T 451 m, T 468 m.
Container Testing (6)
T 800 sm, T 801 sm, T 802 m, T 803 m, T 804 m, T 805 sm
Drying and Ventilating (2)
E 200 p, E 203 p
Fibrous Materials Testing (6)
T 7 p, *T 8 sm*, T 11 m, T 14 m, T 16 m, T 18 m.
Graphic Arts (1)
T 479 sm
Microbiological Control Methods (3)
T 228 m, T 449 m, T 631 m
Microscopy (2)
T 10 m, T 401 m
Mill Design and Economic Aspects (1)
E 1 p
Mill Instruments Control (1)
M 400 p
Mill Maintenance and Materials (1)
E 400 s
Nonfibrous Materials Testing (32)
T 600 m, T 601 m, T 602 m, T 603 m, T 604 m, T 605 m, T 606 m, T 607 m, T 608 m, T 609 m, T 610 m, T 611 m, *T 612 m, T 613 m, T 614 m, T 615 m, T 616 m*, T 617 m, *T 618 m, T 619 m, T 621 m*, T 622 m, T 623 m, T 624 m, T 625 m, T 626 sm, T 627 m, T 628 m, T 629 m, T 630 m, T 632 m, T 634 m
Optical Properties (7)
T 216 m, T 217 m, *T 424 m, T 425 m, T 442 m*, T 452 m, T 633 m
Packaging Materials Testing (8)
T 446 m, T 472 m, T 473 m, T 474 m, T 475 m, T 476 m, T 477 m, T 806 sm
Paper Testing (38)
T 400 m, T 402 m, T 403 m, T 404 m, *T 409 m*, T 410 m, *T 411 m*, T 414 m, T 423 m, *T 426 m*, T 427 m, *T 431 m, T 432 m*, T 433 m, *T 437 m*, T 440 m, *T 441 m, T 445 sm*, T 447 m, T 448 m, T 453 m, T 454 m, T 455 sm, T 457 m, T 458 m, T 459 m, T 460 m, T 461 m, T 462 m, T 463 m, T 464 m, T 465 sm, T 466 m, T 467 m, T 469 sm, T 470 m, T 471 m, T 478 sm
Pulp Testing (12)
T 200 m, T 205 m, *T 210 m*, T 213 m, T 218 m, T 219 m, T 220 m, T 221 m, T 224 sm, T 225 sm, T 226 sm, T 227 m
Steam and Power (2)
E 201 p, E 202 p
Water (6)
E 2 p, E 600 s, E 601 s, E 602 s, E 603 s, T 620 m
Wet Strength (1)
T 456 m

Specific Gravity (Density) and Moisture Content of Pulpwood*

Revision of TAPPI Tentative Standard T 18 m-47

THIS METHOD is applicable to pulpwood chips and disks from the cross section of logs.

Pulpwood is usually purchased and handled on a volume basis. In processing it, however, it is desirable to know its moisture content and moisture-free weight in order to conduct pulping operations properly and to determine the percentage yield of pulp on a weight basis. The specific gravity or density of pulpwood relates wood volume to its weight.

Specific gravity (sp. gr.) is the ratio of the mass of a quantity of a substance to the mass of an equal volume of water. It is an absolute value and, since it is a ratio of similar quantities, is expressed without units. Density is the ratio of the mass of a quantity of a substance to the volume of that quantity and consequently is expressed in terms of weight per unit volume.

Since wood swells or shrinks, respectively, with absorption or loss of water, it is necessary to express the specific gravity at specified conditions of moisture content and volume. The most usual conditions are the moisture-free weight† and the maximum (green) or the minimum (moisture-free) volume. For most purposes, the maximum volume basis is sufficient. In the method described here the specimen is considered to be swelled to its maximum volume when its moisture content exceeds the "fiber-saturation point," which lies between 18 and 26% by weight (wet basis) for most species. Procedures for obtaining the volume on both the green and moisture-free bases are described in this method.

APPARATUS

1. *Weighing Scales.* A balance with a capacity of 14 to 16 kg. (30 to 35 pounds) and sensitive to 0.5 gram, preferably with a sliding-weight beam graduated in grams (or 0.001 pound).

2. *Drying Oven.* A drying oven maintained at 220 ± 5°F. (105 ± 3°C.).

3. *Centrifuge (for chips).* A centrifuge of the basket type, capable of holding a sample of $^3/_4$ to 1 pound (350 to 500 grams) of chips, operated at a constant speed between 800 and 1200 r.p.m. A satisfactory basket can be made of $^3/_{32}$-inch thick brass from 6 to 8 inches in diameter and about 5 inches deep, and perforated with $^3/_{16}$-inch diameter holes on $^1/_2$-inch centers in the side and bottom.

4. *Chip Holder.* A suitable holder consists of a wire-mesh basket of 8- to 10-mesh heavy-gage copper or bronze wire, about 6 inches in diameter and 8 inches high, with a wire-mesh hinged lid provided with a clasp and fitted with a wire-loop handle so arranged that the lid may be opened and closed while the basket is hanging by the handle. The holder should be made heavy enough to sink in water when filled with a sample of chips lighter than water. Variations in design of the chip holder are permissible.

5. *Disk Holder.* A suitable holder consists of a $^3/_{16}$-inch diameter rod, 8 to 10 inches long, with one end fitted into the center of a brass or bronze disk about 4 inches in diameter and $^1/_4$ inch thick. The side of the disk opposite the rod is fitted with three prongs about $1^1/_4$ inches long and $^1/_8$ inch in diameter. The sharpened points of the prongs are equidistantly spaced about 3 inches. Variations in design of the disk holder are permissible.

6. *Auxiliary Apparatus.* Ring stand and clamps. Pans and other containers for use in soaking samples and obtaining their submerged weights. Devices for suspending samples in water while obtaining their submerged weights by Method 2. Counterbalance and tare weights.

REAGENTS

A. *Shellac Solution.* Commercial shellac varnish (containing 5 pounds of ordinary orange shellac per gallon of denatured alcohol) diluted with an equal volume of alcohol.

B. *Kerosene.* Ordinary commercial grade.

C. *Paraffin Wax.* Ordinary commercial grade.

TEST SPECIMEN

(a) Disks

Select a number of sample logs representative of the material being tested. Saw from each log selected for test a disk of solid wood from $^3/_4$ to 1 inch thick from an undamaged, sound, and knot-free section. If possible, cut the disks from the center or at least a foot from the end of each log so as to avoid end checks, and obtain the disk from the least dry portion. Use a sharp, clean-cutting saw. Remove any bark, adhering splinters, and sawdust from each disk. Saw into smaller sections any

* This method has been approved as a tentative standard by the Fibrous Materials Testing Committee. Criticisms are earnestly requested and should be sent to R. G. Macdonald, Secretary, Technical Association of the Pulp and Paper Industry, 122 E. 42nd St., New York, N. Y.

† Many wood technologists believe that the specific gravity of wood is truly expressed only on the basis of moisture-free weight and maximum (green) volume.

disks too large for the can or vessel used for obtaining the submerged weight and mark them for identification. Place the specimen disks in a covered container as soon as cut, to prevent loss of moisture.

(b) Chips

From 0.60 to 0.75 pound (300 to 350 grams) of chips are required for one determination. Chips shall be tested at least in duplicate. Select the chips so as to be representative of the material being tested. Unless previously screened to the desired size, remove sawdust and undersized chips by shaking on a 3-mesh sieve. Store the chip sample in a closed container until ready for further preparation.

TOLERANCE IN WEIGHING

All weighings shall be made to the nearest gram or 0.002 pound.

MOISTURE CONTENT

Though not required for determining the density or specific gravity, it is convenient to determine the moisture content of the sample at this time. For this purpose obtain the initial weights, A and B, respectively, of the specimen disks and chips as sampled, and calculate the moisture content from the moisture-free weights of the specimens which are obtained subsequently.

SPECIFIC GRAVITY OR DENSITY

1. Soaking

Submerge the sample, whether disks or chips, in water at room temperature for at least 1 hour, or longer if necessary.

The purpose of soaking the wood is two-fold: first to insure that the specimen is swelled to its green volume, and second to eliminate an error which occurs if the wood absorbs water during the weighing operation for obtaining its volume. Thus it is necessary to insure that the internal cavities be practically filled with water prior to weighing when submerged, so that further absorption during this weighing is negligible. When the moisture content is above the fiber-saturation point, a 1-hour soaking period is usually sufficient to accomplish both these conditions; otherwise the soaking should be prolonged until checks, if any, are closed.

2. Draining

(a) *Disks.* Let the free water drain from the soaked disks by standing them on edge for a short time and then patting with a cloth or piece of blotting paper just prior to weighing. While draining, the disks should not be exposed to a draft, fan, or direct heat. Disks whose surfaces show signs of drying out before the weighings can be completed should be returned to the soaking vessel.

(b) *Chips.* Allow the sample of soaked chips to drain in a wire-mesh basket for a few minutes, then place in the centrifuge basket and centrifuge for a standardized period of time and speed determined as described in the following section 3.

3. Standardization of Speed and Time of Centrifuging

Determine the specific gravity of identified disks sawed from the ends and middle of a number of correspondingly identified pulpwood logs, representative of the species and kind of wood, according to one of the procedures described in this method. Convert the remaining pieces of the logs to chips, and mix and keep the chips from each log separate.

Weigh out the same chosen quantity of several samples of the chips from each log. Soak and drain the chip samples as described above.

Centrifuge the soaked chips at various speeds and times varying from 800 to 1200 r.p.m. and 1 to 4 minutes. Immediately after centrifuging each sample determine its green volume by one of the methods described. Dry and weigh the chip samples and compute their specific gravities.

For each condition of time and speed, calculate the per cent difference, plus or minus, of the average specific gravity of the chip samples determined from the average specific gravity of the disks from the same log. Calculate the average per cent variation for all the logs for each condition of time and speed. Adopt as the standard conditions a time and a speed for the chosen quantity of chips at which this average per cent variation of the chips from the disks is within ± 1.

4. Determination of Green Volume

In determining the volume of the specimen it is the outside boundary, exclusive of surface depressions, that is required. For this reason the disks or chips should be cleanly cut and all cracks and checks swelled with water until they are closed.

One of the most accurate methods of obtaining the volume of an object is by displacement in a liquid, usually water. The procedures given may be varied both as to apparatus and operation. Variations are permissible so long as they adhere to the fundamental principle involved. Two procedures are described as Method 1 (On the Balance) and Method 2 (Off the Balance).

METHOD 1 (ON THE BALANCE)

(a) Disks

Place a vessel holding enough water at room temperature to completely immerse an 8- or 9-inch diameter disk on the left-hand pan of the scales, and counterbalance the weight of the container and water. Keep the counterbalance on the pan throughout all subsequent operations.

Impinge a drained disk on the three-pronged rod and carefully lower the disk into the vessel so as not to entrap bubbles of air. In a completely submerged position and not touching either sides or bottom of the vessel, clamp it by means of the ringstand and clamp. If not more than $^1/_2$ inch of the prongs are immersed, the volume of water displaced by them will be negligible. Again balance the scales. The weight added to restore balance is the weight, C, of the volume of water equivalent to the volume of the specimen.

Note: Disks too large for the container should have been cut into two or more pieces and properly identified prior to soaking. The above operations are performed on each piece separately and the weights added to obtain the weight, C, for the whole disk.

Remove the disk and add water to the vessel until it is counterbalanced again before immersing the next specimen.

(b) Chips

Counterbalance on the scales a vessel containing

enough water at room temperature to freely submerge the chip holder. Keep the counterbalance on the pan throughout all subsequent operations. Completely submerge the *empty* chip holder, except for its wire handle, which hooks onto a support, on the ringstand. The chip holder must not touch the sides or bottom of the vessel. Obtain the weight, D, of the volume of water equivalent to the volume of the *empty* chip holder, which is that of the weights necessary to add to the right-hand pan to secure a balance.

Transfer the sample of chips from the centrifuge to the chip holder. Slowly lower the chip holder with chips into the counterbalanced vessel of water. Before hooking the handle onto the support, give the holder a quick twist clockwise and then counterclockwise to release any bubbles of air that might have been entrapped. Place a tare weight equivalent to D on the right-hand pan. Obtain the weight, E, of the volume of water equivalent to the volume of chips, which is that of the weights necessary to add to the tare weight on the right-hand pan to secure a balance.

Remove the chip holder from the vessel and remove all weights except the counterbalance from the scale. Add water to the vessel until it is balanced again before immersing the next sample.

METHOD 2 (OFF THE BALANCE)

(a) *Disks*

Prior to removing the disks from the soaking vessel, note and segregate those that sink and those that float.

Set the scales on the right end of a table so constructed that specimens can be suspended from the right-hand pan. Place a vessel of sufficient size containing water at room temperature below the scales directly under the right-hand pan. Hang on the right-hand pan a stirrup and chain or other convenient device with screw clamp for attaching and adjusting the three-pronged disk holder. Counterbalance the stirrup and disk holder and keep the counterbalance on the scale throughout all subsequent weighings.

Obtain the weight, F, of the soaked, drained disk. Immediately impinge the disk on its holder and carefully lower it into the water so as not to entrap air. Adjust and clamp the disk holder in the stirrup with the disk completely immersed and not touching the sides or bottom of the vessel.

Alternative Procedure: Instead of immersing the disk horizontally, it may be suspended edgewise (vertically) by clipping it to a large battery clamp attached to a light chain or cord which is hung from the right-hand pan of the scales. Another large battery clamp to which is fastened a weight or plummet is clipped to the lower edge of the disk. Since the plummets need only be heavy enough to sink the disk and steady it in a vertical position, two or three different weights for larger and smaller disks are provided. The counterbalance weight is obtained with the plummet and clamps immersed in the water.

Case I: The disk is lighter than water. Obtain the weight, G, required to restore balance by adding weights to the right-hand pan. The weight of the volume of water equivalent to the volume of the disk is $(F + G)$, that is, it is equal to the weight of the soaked disk in air plus its weight suspended in water.

Case II: The disk is heavier than water. Balance the scale by adding weights, H, to the left-hand pan. The weight of the volume of water equivalent to the volume of the disk is $(F - H)$, that is, it is equal to the weight of the disk in air minus its weight suspended in water.

After weighing the immersed disk, raise (but do not remove) the holder from the stirrup, and remove the disk from the holder. Remove all weights except the counterbalance from the scales.

(b) *Chips*

Hang a stirrup, as described for disks, to the right-hand pan of the scales. Immerse the *empty* chip holder in the vessel of water and suspend it from the stirrup. Counterbalance the stirrup and immersed chip holder by adding weights to the left-hand pan. Keep the counterbalance weight on the scale throughout all subsequent weighings.

Obtain the weight, I, of the sample of soaked, centrifuged chips and transfer them immediately to the chip holder. Carefully lower the chip holder with chips into the vessel of water, give the holder a quick twist clockwise and then counterclockwise to release bubbles of air, and suspend it from the stirrup.

Case I: The chip sample floats in water. Obtain the weight, J, required to restore balance as for a disk lighter than water. The weight of the volume of water equivalent to the volume of the chips is $(I + J)$.

Case II: The chip sample sinks in water. Obtain the weight, K, required to restore balance as for a disk heavier than water. The weight of the volume of water equivalent to the volume of chips is $(I - K)$.

Remove all weights except the counterbalance from the scale before immersing the next sample.

Note: The choice of displacement method will depend largely on the individual analyst and the laboratory facilities available. Method I does not require obtaining the weight of the water-soaked specimens but requires adding water to the vessel on the pan to restore balance after each determination. A bottle of water with syphon and pinch clamp will facilitate adding water to the pan. With Method 2 the vessel of water does not have to be rebalanced each time. The water, if spilled, is below the table top and records are not apt to be spoiled thereby. On the other hand, the weight of the soaked specimens is required and a different method of calculation for "floaters" and "sinkers" is necessary.

5. *Determination of Moisture-Free Weight*

Place the disks on the shelves of the drying oven so that they do not touch each other. Spread out the chips in a wire-mesh tray or basket in the oven. Dry the disks and chips to constant weights, L and M, respectively, which will require from 24 to 48 hours.

6. *Determination of Moisture-Free Volume*

(a) *Disks.* Dip the dried disks, after weighing and while still warm, into hot paraffin wax, which gives a waterproof seal of negligible volume. Scrape, or if hot enough, wipe off surplus paraffin. Determine the weight of water, N, equivalent to the volume of the disk by Method 1 as described for the water-soaked samples. Alternatively, using Method 2, obtain the weight, O, of the paraffined disk in air before obtaining its weight suspended in water. Let the submerged weight of the disk be P for Case I (disk lighter than water) and Q for Case II (disk heavier than water).

(b) *Chips.* Because of the proportionately high volume of paraffin coating on a quantity of chips as compared to that on an equal quantity of wood in the form of disks, as well as the difficulty of immersing the basket of paraffined chips in water without entraining air, the determination of the volume of dried chips by this method is not recommended. The volume can,

however, be obtained satisfactorily by coating the chips with shellac and immersing them in kerosene.

Immerse the dried chips, after weighing and while still warm, preferably contained in a wire basket, in an alcoholic solution of commercial shellac for a period of 3 to 5 minutes and then spread out to air dry. Determine the weight of kerosene, R, displaced by the chips by Method 1 as described for water-soaked chips. Alternatively, using Method 2, obtain the weight, S, of the shellac-coated chips in air before obtaining the weight suspended in kerosene. Let the submerged weight of the chips be T for Case I (chip sample lighter than kerosene) and U for Case II (chip sample heavier than kerosene).

REPORT

Moisture Content

Report the results on the "as-received" basis to the nearest 0.1 per cent moisture calculated as follows:

$$\text{Disks: } \frac{A - L}{A} \times 100 = \% \text{ moisture}$$

$$\text{Chips: } \frac{B - M}{B} \times 100 = \% \text{ moisture}$$

Specific Gravity

The specific gravity as determined by the various procedures described is computed by the formulas given in Table I. The calculation shall be made separately for each disk or sample of chips and the average of all disks or of all samples of chips reported. The calculation for both individual specimens and the average shall be made to three significant figures.

Note: Since the specific gravity of pulpwood is primarily used in estimating the weights of solid volumes, it is important that the average of the disks be representative of the weight per unit volume of the wood under test. Because of the varying diameters of the logs from which the disks are cut and the fact that specific gravity often varies with diameter, it is recommended that a weighted average, based on the volume of the disks, be computed. The formula for this weighted average is $\frac{\text{sum of the products } Sd^2t}{\text{sum of the products } d^2t}$ where S, d, and t are, respectively, the specific gravity, diameter measured to the nearest 0.1 inch, and thickness measured to the nearest 0.1 inch of each disk. If the thicknesses of the disks do not vary more than $\pm 1/16$ or 0.06 inch from the average thickness, t may be eliminated from the equation. The diameter of the disks, which should be measured prior to drying, can be quickly determined with a steel diameter tape or by taking the average of two diameters measured at right angles.

Density

Density expressed as grams per cubic centimeter is numerically equal to the specific gravity. Density expressed as pounds per cubic foot is obtained by multiplying the specific gravity by 62.4.

A report of specific gravity or density is not complete without a statement of the basis of determination, i.e., "Moisture-free weight per green volume" or "Moisture-free weight per moisture-free volume."

Table I.—Formulas for Computation of Specific Gravity

Method of volume determination	*Basis of specific gravity determination: Moisture-free weight per green volume* — *Disks*	*Chips*	*Moisture-free weight per moisture-free volume* — *Disks*	*Chips*
Method 1	$\frac{L}{C}$	$\frac{M}{E}$	$\frac{L}{N}$	$\frac{MV}{R}$
Method 2				
Case I—Specimen lighter than suspension liquid	$\frac{L}{F + G}$	$\frac{M}{I + J}$	$\frac{L}{O + P}$	$\frac{MV}{S + T}$
Case II—Specimen heavier than suspension liquid	$\frac{L}{F - H}$	$\frac{M}{I - K}$	$\frac{L}{O - Q}$	$\frac{MV}{S - U}$

Table II.—Definitions of Symbols

Definition	*Disks: Containing moisture**	*Disks: Moisture-free*	*Chips: Containing moisture**	*Chips: Moisture-free*
Weight of specimens	A	L	B	M
Weight of liquid displaced by green, or dry and coated, specimens according to Method 1	C	N	E	R
Weight of green, or dry and coated, specimen	F	O	I	S
Weight required to restore balance of scales when determining weight of liquid displaced according to Method 2, Case I "floaters"	G	P	J	T
Weight required to restore balance of scales when determining weight of liquid displaced according to Method 2, Case II "sinkers"	H	Q	K	U
Weight, or equivalent weight, of water displaced by specimens lighter than the liquid used in Method 2. V represents the sp. gr. of kerosene	$F + G$	$O + P$	$I + J$	$\frac{S + T}{V}$
Weight, or equivalent weight, of water displaced by specimens heavier than the liquid used in Method 2. V represents the sp. gr. of kerosene	$F - H$	$O - Q$	$I - K$	$\frac{S - U}{V}$

* A and B represent the weights of specimens as-received. All other weights of specimens in these columns represent wood in the water-soaked or green condition.

EMPLOYMENT SERVICE

Positions Open

P53-50. Technical sales. College graduate 35 years or younger. Practical experience in paper making or coating required.

P54-50. Chemist with paper industry background or recent graduate of pulp and paper college for container plant in the east.

P55-50. Paperboard mill chemist or chemical engineer for midwest mill to develop paperboard specialties. Knowledge of sizing, surface coating, impregnation, and lamination. Work in mill and laboratory.

P56-50. Paper Maker. Large eastern book paper mill. Exceptional opening for a practical, highly skilled paper machine operator. Must have established outstanding operating record in his present job and desire new connection to attain increased opportunity and compensation. Must have education, training, and experience to assume full responsibility for the operating efficiency and product quality of several large machines. Book paper experience preferred but not essential.

Positions Wanted

E64-50. Former pulping research director. 34. Available in New York City or vicinity during evenings and week ends for consultation on pulping deciduous woods, high-grade alpha hardwood pulps, specialty products, bleaching, etc. Presently employed in noncompetitive chemical industry as a research group leader.

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Ralph Aarons, Chemist, E. I. du Pont de Nemours & Co., Experimental Station, Wilmington, Del., a 1939 graduate of University of Maryland.

Ralph B. Baker, Librarian, American Viscose Corp., Marcus Hook, Pa., a 1929 graduate of Johns Hopkins University with a Ph.D. degree.

Eilif Bang, Managing Director, A/S Tofte Cellulosefabrik, Oslo, Norway.

Kshiroda K. Baruwa, Student, University of Maine, Orono, Me., a 1946 graduate of Banaras University.

Robert J, Becker, Student, New York State College of Forestry, Syracuse, N. Y.

Rolfe C. Bradbury, Assistant to Division Manager, The Mead Corp., Chillicothe, Ohio, a 1925 graduate of Northeastern University.

Claes O. Berggren, Student, New York State College of Forestry, Syracuse, N. Y.

Everett D. Cann, Research Chemist, Howard Smith Paper Mills Ltd., Cornwall, Ont., Canada, a 1941 graduate of the University of New Hampshire, with a Ph.D. degree from McGill University in 1946.

Ujagar S. Cheema, Chief Chemist, Jaswant Strawboard Mills Ltd., Meerut, U. P., India, a 1930 graduate of F. C. College, Lahore.

Paul E. Clark, Chemical Engineer, The Crystal Tissue Co. Middletown, Ohio, a 1942 graduate of Ohio State University.

Gustave Delaudiere, Engineer, Societe des Papeteries Navarre, Paris, France, a 1924 graduate of Ecole Centrale de Paris.

Harry L. Dickey, Supervisor of Paper Standards, New York & Pennsylvania Co., Johnsonburg, Pa., a 1948 graduate of Pennsylvania State College.

Robert S. Ellis, Chemist, S. D. Warren Co., Cumberland Mills, Me., a 1947 graduate of Norwich University.

Roswell P. Fallon, Control Superintendent, St. Regis Paper Co., Harrisville, N. Y., a 1948 graduate of Clarkson College.

Matthew C. Hall, Laboratory Technician, Oregon Pulp & Paper Co., Salem, Ore.

David D. Humphreys, Group Leader, Sharples Chemicals, Inc., Wyandotte, Mich., a 1941 graduate of Texas University with a Ph.D. degree.

Waldemar Jensen, Teacher, Wood Chemistry, Abo University, Abo, Finland, a 1948 graduate of Abo University with a Ph.D. degree.

Harry M. Johnquest, Chief Chemist, The Bristol Co., Waterbury, Conn., a 1909 graduate of Pratt Institute.

Anthony Kinsel, Superintendent in charge of Petrolatum and Wax Manufacture, Daugherty Refinery, Petrolia, Pa., a 1910 graduate of Institute of Polytechnic, Prague.

Robert G. Lacey, Assistant to Production Superintendent, The Celotex Corp., Marrero, La., a 1936 graduate of Loyola College.

Arthur H. Lambert, Student, New York State College of Forestry, Syracuse, N. Y.

Henry J. Lawler, Sales Development Engineer, Monsanto Chemical Co., Everett, Mass., a 1939 graduate of University of New Hampshire, with an M.S. degree in 1941.

Leslie G. McGowan, Student, New York State College of Forestry, Syracuse, N. Y.

Walter S. Miller, Chief Fuels and Lubricants Engineer, Gulf Oil Corp., Pittsburgh, Pa., a 1934 graduate of Lehigh University.

Henry W. Mooseker, Paper Mill Superintendent, West Virginia Pulp & Paper Co., Tyrone, Pa., a 1940 graduate of the College of the City of New York.

Edward L. Morin, Food Technologist, Seabrook Farms Co., Bridgeton, N. J., a 1939 graduate of the University of Massachusetts.

Horst W. Niethammer, Technical Manager, Heinrich Nicolaus G.m.b.H., Kempten/Allgau, Germany, a 1929 graduate of Tubingen, Munchen, Dresden.

Dewey H. Nelson, Chemist, Buffalo Electro-Chemical Co., Inc., Buffalo, N. Y., a 1947 graduate of Massachusetts Institute of Technology.

William F. Nye, Jr., Field Representative, The Hubinger Co., Keokuk, Iowa, a 1932 graduate of the University of Massachusetts.

Perry J. Ostberg, Quality Control, The Jaite Co., Jaite, Ohio, a 1946 graduate of Orebro Handelsgymnasium.

Aldo J. Pin, Technical Sales Service, Penick & Ford Ltd., Inc., New York, N. Y., a 1948 graduate of Lehigh University.

Louise E. Pritchard, Librarian, Library Association of Portland, Portland, Ore.

Donald H. Putnam, Manager of Sales, General Electric Co., Schenectady, N. Y., a 1937 graduate of North Dakota State University.

William P. Ridenour, Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa., a 1929 graduate of Columbia University.

Frank A. Root, Salesman, Clinton Foods, Inc., Clinton, Iowa.

Alexandre Ruby, Director of Research, Papeteries de France, Grenoble, Isère, France. Attended Ecole Francaise de Papeterie.

Homer P. St. Clair, Chemist, Hawthorne Paper Co., Kalamazoo, Mich. Attended Butler University and the University of Indiana.

Robert M. Schneble, Tour Foreman, Coosa River Newsprint Co., Coosa Pines, Ala., a 1938 graduate of University of Dayton.

R. Lawrence Scoville, Chemist, Hollingsworth & Whitney Co., Winslow, Me., a 1941 graduate of New York State College of Forestry.

John E. Shade, Research Chemist, Wyandotte Chemicals Corp., Wyandotte, Mich., a 1939 graduate of Lawrence Institute of Technology.

Vaino H. Somer, Technical Manager, Aktiebolaget Kaukas Fabrik, Lauritsale, Finland, a 1928 graduate of Technical Institute of Finland.

James A. Stenstrom, Manager, Pulp & Paper Division, Canadian Ingersoll-Rand Co. Ltd., Montreal, P. Q., Canada, a 1940 graduate of McGill University.

Howard W. Stevens, Mechanical Engineer, S. D. Warren Co., Cumberland Mills, Me., a 1934 graduate of the University of Maine.

Rene Stevens, Chemist, Gavaert Photo Production N. V., Mortsel-Antwerp, Belgium.

Alexander Taylor, Chief Engineer and Secretary, The Titaghur Paper Mills Co. Ltd., Calcutta, India. Attended Heriott-Watt College, Edinburgh, Scotland.

James L. Tennant, Jr., Chemical Engineer, Bird & Son, Inc., East Walpole, Mass., a 1950 graduate of University of New Hampshire with an M.S. degree.

Stanley W. Trosset, Jr., Chemist, Gardner Board & Carton Co., Middletown, Ohio, a 1948 graduate of Transylvania College.

Charles R. Ward, Jr., Student, New York State College of Forestry, Syracuse, N. Y.

Blanchard D. Warren, Assistant Sales Manager, Bird Machine Co., South Walpole, Mass., a 1924 graduate of Massachusetts Institute of Technology.

Thurman C. Warren, Jr., Technical Superintendent, International Paper Co., Ticonderoga, N. Y., a 1929 graduate of Cornell University.

Johannes G. Weeldenburg, Director, Algemene Kunstzijed Unie N. V., Arnhem, Holland, a graduate of Delft College with a Ph.D. degree.

Everett R. Wiles, Director of Research and Development, Bareco Oil Co., Barnsdall, Okla., a 1915 graduate of Baker University.

Edgar R. Zimmerman, Project Leader, Minnesota & Ontario Paper Co., International Falls, Minn. Attended the University of Minnesota and the University of Michigan.

TAPPI Notes

Paul C. Baldwin is now Assistant to the General Manager of Paper Mills, Scott Paper Co., Chester, Pa. Mr. Baldwin was formerly Paper Mill Superintendent.

Henry H. Bell is now General Superintendent of the New York & Pennsylvania Co. mill at Johnsonburg, Pa. Mr. Bell was formerly Head of the Paper Standards and Inspection Dept.

Walter J. Bublitz, Jr., formerly of the Lithographic Technical Foundation is now Chemist for the Munising Paper Co., Munising, Wis.

Harry G. Davis, formerly of the Ozalid Div., General Aniline & Chemical Co., is now General Superintendent of the Maine Coating Mills Div., Oxford Paper Co., Rumford, Me.

Henry J. Driscoll, formerly of the Union Bag & Paper Corp., is now Plant Manager, Alfol Insulating Div., Reflector Corp., Hudson Falls, N. Y.

Joseph Edwards is now Manager of Manufacturing, Price Bros. Co., Ltd., Kenogami, P. Q.

George H. Gallaway, formerly of the Crown Zellerbach Corp., is now Resident Manager, National Paper Products Corp., Carthage, N. Y.

Philip Goldstein, formerly of Geo. O. Jenkins Co., is now Technical Director Lynn Wood Heel Co., Keene, N. H.

Allen H. Gridley, formerly of H. S. Ferguson Co., is now located at 452 First Ave., Pelham 65, N. Y.

Arthur J. Haug is now Technical Director, Scott Paper Co., Chester, Pa.

John T. Hegeman, formerly of Congoleum Nairn, Inc., is now Chemical Engineer, Brown Co., Berlin, N. H.

Frederick Herbolzheimer, Jr., is now Manager of Technical Control, Marinette Paper Co., Glens Falls, N. Y.

Earl H. Johnson, formerly of Stillwater Tissue Mills, is now with Stevens & Thompson Paper Co., Greenwich, N. Y.

Donald W. Light, formerly of the Ludlow Mfg. & Sales Co., is now Director of Research, Angier Corp., Framingham, Mass.

William W. Marteny, formerly of Falls Paper & Power Co., is now with the National Container Corp. of Wisconsin, Tomahawk, Wis.

L. W. McFail is now Technical Superintendent, Maine Coating Div., Oxford Paper Co., Rumford, Me.

Lewis B. Newman, formerly Chief Engineer of Phil-Fibre Box Board Mills, Inc., is now Vice-President of Newman & Co., Philadelphia, Pa.

Hugh C. Osborn is now Service Engineer, R. T. Vanderbilt Co., Portland, Ore. Mr. Osborn was formerly at E. Norwalk, Conn.

Royal D. Packard is now Plant Engineer, J. & J. Rogers Co., Ausable Forks, N. Y.

J. C. Parsell is now General Manager of the Plastic Products Div., J. P. Lewis Co., Beaver Falls, N. Y.

Henry Reeves, Jr., of the Paper Makers Chemical Dept., Hercules Powder Co., has been transferred from Atlanta, Ga., to Wilmington, Del.

Howard Roderick is now General Sales Manager, Michigan Alkali Div., Wyandotte Chemicals Corp., Wyandotte, Mich.

Raymond J. Schadt, formerly of the National Paper Products Co., is now Resident Manager, Crown Zellerbach Corp., Port Angeles, Wash.

Harold P. Vannah, Sr., formerly Director of Plant Research Dept., Central Fibre Corp., Pisgah Forest, N. C., is now with the Department of Horticulture, University of Maine, Orono, Me.

Herbert Wymore is now Manager of the Crown Zellerbach mill at Lebanon, Ore.

Edmund A. Yerger, formerly of the Moore & White Co., is now with the Edward J. McBride Co., Philadelphia, Pa.

Erik Zimmerman is now General Superintendent, the Chesapeake Corp., West Point, Va.

* * *

J. H. Ford, Chief Engineer, Central Div., Container Corp. of America, Chicago, Ill., has succeeded C. P. Barker as the official corporate representative of the Company in TAPPI.

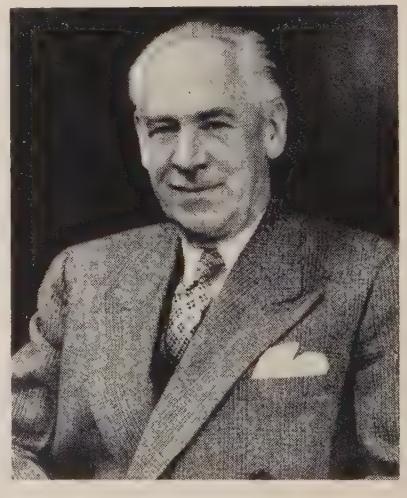
G. F. Underhay, formerly of Edward Lloyd Ltd., is now with Bowaters Development & Research Ltd., London, W. 1., England, and is official corporate representative in TAPPI.

* * *

John W. Ogden has succeeded Pell Foster as official representative of the Foster Wheeler Corp., New York, N. Y., in TAPPI.

O. D. Ogle has succeeded D. C. Cummings as the official representative of SKF Industries, Inc., Philadelphia, Pa., in TAPPI.

Andrew G. Spiegelhalter, President of The Pusey and Jones Corp., Wilmington, Del., papermaking machinery manufacturers, was honored at a dinner held on January 19 at the Hotel Du Pont, Wilmington. Hosts were the directors and officers of The Pusey and Jones Corp. and associated companies. The dinner commemorated Mr. Speigelhalter's completion of 50 years of continuous association with The Pusey and Jones Corp., one of America's oldest papermaking machinery manufacturers.



Andrew G. Spiegelhalter

John P. Pulliam, Chairman of the Board, was toastmaster, and Wm. Merrill Chester, a Director, presented Mr. Spiegelhalter with a silver bowl suitably inscribed in recognition of a half century of capable and outstanding service with The Pusey and Jones Corp.

Mr. Spiegelhalter's rise to President of the company reflects an impressive record as an employee and as an executive. He was elected President on Jan. 1, 1939. He joined

Pusey-Jones as an apprentice machinist at the turn of the century, Jan. 1, 1900, representing the third generation of Spiegelhalters to enter the employ of the company. This 100-year-old firm, which built its first two papermaking machines in 1867, later built machines which set the pace for modern, high-speed, large-tonnage production of many types of paper.

Mr. Spiegelhalter's first nine years found him successively in practically all of its productive departments and by 1916 he was Plant Manager. He soon occupied a leading role in the manufacture of the company's chief product: papermaking machinery. In 1928, as Works Manager, he took charge of the entire productive efforts of the Pusey-Jones Plant. In 1932, he was elected Vice-President, still giving supervision to the manufacture of papermaking machinery and other products.

In 1938, Mr. Spiegelhalter was made Vice-President and General Manager and within a year was promoted to the chief executive in the firm, succeeding J. P. Pulliam, of Milwaukee, who became Chairman of the Board.

Under Mr. Spiegelhalter's direction, the first two 226-inch, high-speed machines for Fraser Paper, Ltd., Madawaska, Me., were built. Another outstanding machine was the first high-speed Fourdrinier machine for making newsprint from Southern Pine. This 234-inch machine, installed at the Southland Paper Mills, Lufkin, Tex., launched a new source of supply of newsprint. It was the first machine equipped with "Rapi-drape" Method for installing Fourdrinier wire.

Mr. Spiegelhalter also took a supervisory role in the development of the First Stream Flow Vat System, and later the first Flow Spreader arrangement which was installed on a Kraft Fourdrinier machine in the south. The installation also included the first Simplex Press arrangement.

Industry Notes

P. Edward Rollhaus of the Wallerstein Co., Inc., was awarded a scroll by the Philadelphia Section of the A.C.S. as one of the members whose services had contributed most to the Section's growth in its 50-year history.

* * *

The De Laval Steam Turbine Co., Trenton, N. J., has issued a bulletin "G-WB, IMO-De Laval Worm Gear Speed Reducers". It shows the available types, horsepower rating tables and information on how to select worm gears.

* * *

Bird Machine Co., S. Walpole, Mass., has issued an interesting bulletin, illustrating the uses of the Dirtec.

* * *

Hydrogen peroxide solutions of 27.5, 35, and 50% concentration are described in a new bulletin prepared by the Buffalo Electro-Chemical Co., Inc., Station B, Buffalo 7, N. Y. It contains a compilation of physical data and applications of hydrogen peroxide.

* * *

Bienfang Paper Co. has discontinued its New York office. All operations are centered in Metuchen, N. J.

* * *

National Adhesives Div., National Starch Products, Inc., 270 Madison Ave., New York 16, N. Y., has issued a chart and booklet on "How to Handle Adhesives for Transparent Films." It is pointed out that although most transparent films appear to be quite similar, various types vary widely, both as to properties and reaction to different adhesives. Fourteen groups, according to basic chemical composition are shown. These range from cellophane, through cellulose derivatives to the vinyl halides.

* * *

A portable ion-exchange unit which yields 10-million ohm water has been developed by the Crystal Research Laboratories, Inc., Hartford, Conn. The apparatus, called the Deeminizer, yields up to five gallons per hour of water equal in chemical quality to triple-distilled. It represents the first commercial application of the mixed-bed ion-exchange techniques, recently announced by the Resinous Products Division of Rohm and Haas Co., Philadelphia, Pa. The mixed-bed of specially converted Amberlite exchangers adsorbs sodium, silica, calcium, magnesium, and other ions.

* * *

The Board of Directors of the Japanese Technical Association of the Pulp and Paper Industry and the Supreme Commander of the Allied Powers have accepted the offer to establish the Murdock Prize. The prize will be underwritten by Robert and Company, Atlanta, Ga. Mr. Murdock is now visiting in Japan.

* * *

Ferdinand Wultsch has been invested by the Bundespresident of the Republic of Austria with the title of Extraordinary Professor of the Technical University at Graz, Austria. Dr. Wultsch will lecture on pulp and paper manufacturing subjects.

* * *

The Atlas Mineral Products Co., 41 Walnut St., Nierztown, Pa., has issued a New Bulletin 7-1 on Protective Coatings for Industry. This bulletin contains information on coatings suitable for protection against corrosive fumes or splash on steel, concrete, and wood surfaces.

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel and Events

Ohio

The February meeting of the Ohio Section was held jointly with the Miami Valley Superintendents Division at the Manchester Hotel, Middletown, Ohio, February 9. The attendance was the largest in the history of the Ohio Section with 191 members and guests being present.

After a short business meeting with Chairman Arthur Thurn presiding, John Minnich, Manager of the Manchester Hotel, extended his welcome and appreciation of the business extended the hotel. Mr. Kon Matchuk, Chairman of the Superintendents Association spoke briefly on their next meeting to be held March 9 at the O. M. Hutchins Power Station.

George H. Pringle of Mead Corp. introduced the speaker of the evening, R. A. Packard, Executive Vice-President, Holyoke Machine Co., Holyoke, Mass. Mr. Packard spoke on "The Engineer's Selection of the Paper Machine Drive."

In 1866 a paper machine was classed as large if it was 75 to 104 in. wide and small if 40 to 54 in. wide. The number of drier cylinders varied from a minimum of three to a maximum of 10, with 5 or 6 being average. Great quantities of paper were lost by troubles with drives often occurring three or four times a day. Speeds were varied by applying lagging strips of canvas or felt to the surface of the pulley with lagging wax.

The first real step in drive improvement came toward the end of the last century, when the bevel gear idea was barrowed from the early water wheel corner drives. It was simple addition to apply the cone pulley for each set of gears to handle the draw on each section. As paper machine speeds increased, the open bevel gear arrangement began to show limitations. Vibration would cause the frames to shake and at time affect the passage of paper from one section to another. Increased power demands called for a still more rugged quarter turn drive which resulted in the development of the bevel gear running in oil.

During the years of development various types of drives were developed and used—the Ward Leonard system of variable speed control using a direct-current motor; development of small steam turbines between 1910 and 1920; after the first world war the use of various hydraulic drives used on battleships; enclosing the bevel gear to provide better lubrication; the use of the spiral bevel gear; and finally, for extra-heavy loads the application of the hypoid unit.

With the continual increase in paper machine speeds we are approaching the limitations of the belt drive in both the width of the belt and its lineal speed. This has resulted in the development of the V-belt drive. The setup is simple, of high efficiency, of low cost of installation, and in case of trouble can be easily repaired by a millwright. No basement is required, and only a relatively narrow space from the rear of the machine to the wall is needed.

Inching and reversing drives are important units in a position like the calender where a plugged machine has to be cleared promptly. Helper drives are placed on the machine wherever slippage or undue strain is placed on the felt or wire.

The worm gear is not recommended as a paper machine quarter-turn drive because of relatively low efficiency and consequent heat generation.

The clutch is a necessary evil, but unless you get into a sectional, electronic, or hydraulic drive, some form of clutch must be used. The application on the paper machine requires a simple design capable of smooth acceleration of massive bodies requiring nearly constant torque as well as bodies with very high starting effort, with frequent repetition over a period of trouble on the machine. The opinion today that either a multiple plate exposure or peripheral plate contact to sealed pockets expanded with compressed air is the best combination. Rigid plates of steel against composition disks have the disadvantage of low percentage of contact due to distortion, misalignment, or both.

Speed regulator engineering has been a subject upon which electrical machinery manufacturing companies have spent a great deal of thought and experimentation. Electronic amplification appeared to be the medium through which most accurate and rapid response in speed control could be obtained. The mechanical simplification of the layout is the answer to the paper-mill engineer's prayer. On the other hand there is a great complication of electric circuits which may be a greater potential source of trouble.

The controls for sectional drives are varied in character and too

Left to Right at the speakers' table at the Ohio Section meeting, Kon Matchuk, Roland Packard, George Pringle, and Arthur Thurn

L to R. Ralph Buechler, H. J. Bettner, and Frank Duvall

L to R. W. C. Martin, William Csellak and Charles Piper

L to R. J. Hartford, R. R. Crawford, A. G. Gibson, and G. W. Schafer

L to R. Messrs. Cook, Young, Topp, Weihe, and Cook

involved to describe in detail. Many of these drives operating very satisfactorily do not have electronic equipment, and as such may be purchased at a somewhat lower price.

If someone had said that we would be operating a paper machine 2600 f.p.m. 20 years ago you would have called him visionary. I predict that they will be running 3500 f.p.m. in 1969. That range may extend beyond the scope of mechanical development used in the present corner drives. However, knowing many of this group of engineers I predict that they will continue to forge onward, so that instead of working currently on designs approaching 1800 f.p.m., they will be satisfactorily solving problems encountered at 2800 f.p.m.

The speed at which a paper machine runs is an interesting as well as an economic factor in the successful operation of a paper mill. My study of the subject has led into some interesting channels of thought. What does the over-all picture of the manufacture of paper groups look like when translated into graphs. Two graphs are worthy of comment. Strange as it may seem, facial tissue is manufactured from 350 to 2600 f.p.m. The lower end of this graph refers to a cylinder machine and the upper end to a Yankee. Newsprint is made entirely on the straight fourdrinier. One wonders at the economic status of companies at the lower ends of these two graphs. Since these graphs in general cover groups of paper manufacturing, it is obvious that a particular grade of paper which falls at the lower end of a graph may still be considered as being made at top speed. If you find one of your paper machines operating at the lower end of any graph, question yourself as to why you are there. There may be good and sufficient reasons; however, an examination of the situation may result in an improvement of your speed.

The horsepower requirements of drives on different sections of a paper machine is a subject of great importance as well as the capital cost per horsepower of the various types of drives one installed. The development of the V-belt short center drives out an economical design competitive with the graphs shown above.

In summary, I have tried to give a brief history from which there has been developed the different types of drives on paper machines, together with a general description and illustration of this paper should be made only after an evaluation of the various factors surrounding a proposed paper machine.

After Mr. Packard's very interesting address B. L. Hanna of Corn Products Sales introduced Gene Fekete, Assistant Football Coach, Ohio State University. After a few remarks, Mr. Fekete showed a very interesting movie in slow motion of the Rose Bowl Football Game.

E. O. Knapp, *Recording Secretary*

Delaware Valley

The Dinner Meeting at the Engineer's Club, Philadelphia was attended by over 100 members and guests. Chairman John P. Weidner, presided over the meeting. After welcoming those present he introduced Glen T. Renegar, Chairman of the Pennsylvania-New Jersey-Delaware Division of the Superintendents Association. Mr. Renegar announced the Spring Meeting of the Division which is to be held at York, Pa., on May 5 and 6, 1950.

Chairman Weidner announced that the next meeting of the Delaware Valley Section will be on Thursday, March 23. The topic for the evening's discussion will be on drying. A. E. Montgomery, J. O. Ross Engineering Corp., Chairman of the Drying and Ventilating Committee of the Engineering Division of National TAPPI will be present.

Panel Discussion on Sizing

Chairman Weidner introduced the Panel Leader, Arthur J. Haug, Technical Director of the Scott Paper Co., Chester, Pa. as being the one who organized the panel and worked out the details.

Mr. Haug welcomed all to the panel on sizing and stated that he himself was not an expert on sizing and was in fact, sitting among sizing experts while his organization was striving daily to make soft and very absorbent paper. (general laughter)

Chairman Haug: Our subject for discussion tonight is, literally, as old as the hills, and plays a companion part to that of paper itself in man's development. It has been stated, and truly so, that one of the greatest contributors toward the advancement of man was the invention of paper. The reason being that it furnished the medium for his expression—it gave him opportunity to perpetuate his ideas and thoughts and to communicate with others in separate parts of the earth. An early problem which held back progress was that of the ink being absorbed by the paper. In solving and helping this problem, the role of sizing is clearly seen.

Around 700 A.D., the Orientals covered the surface of sheets with *gypsum*. The Chinese next brought lichen, starch, or rice flour to make the sheet impervious to ink.

Gelatine, rendered from hoofs, hides, and bones of animals also found use. The sheet was dipped into warm size on sticks. This was done in Europe about 1337 A.D. In pressing many sheets were bruised and torn. The sizing room was termed the 'Slaughter House.' Rosin sizing for paper was invented by Moritz Illig in 1807. This patent was sold for $20. A German papermaker, Joseph Krah, is reported to have made the earliest practical use of rosin sizing in paper in the United States in 1830.

Dard Hunter, reporting on an early treatise by a Father Imberdis, listed two tests used for testing sized paper that would give objective specification men of today quite a start. (1) Crumple paper in the hands, if it sounds like parchment under similar treatment, it is shown to be well sized with animal glue. (2) Wet paper with the tongue, if saliva penetrates through the sheet, it is unfit for the application of fluid writing ink.

This same Father Imberdis made a statement about papermaking and its problems which leads us to the program for tonight in recognition of the fact that, advanced as we have become in sizing techniques, many problems still exist, 'Heaven does not permit such a divine art to be made easy for mortals here below.'

The first gentleman on our panel is a graduate of the Massachusetts Institute of Technology as a chemical engineer. His first place of employment following graduation was with the Cochrane Chemical Co., which was taken over by the Merrimac Chemical Co., which in turn, was taken over by Monsanto. That is a true record of success—to do so well in a position as to have the entire company purchased twice to obtain his services. In Monsanto he has held various production jobs, including Manager and for the last 33 years was Research Director of his Division. He is now retired. His work during the latter period was largely that of a physical chemist and in later years his major interest was in colloidal or ion exchange problems in connection with paper making and paper sizing. It was through his theoretical work that Mersize was invented. It gives me a great deal of pleasure to present, Dr. William S. Wilson.

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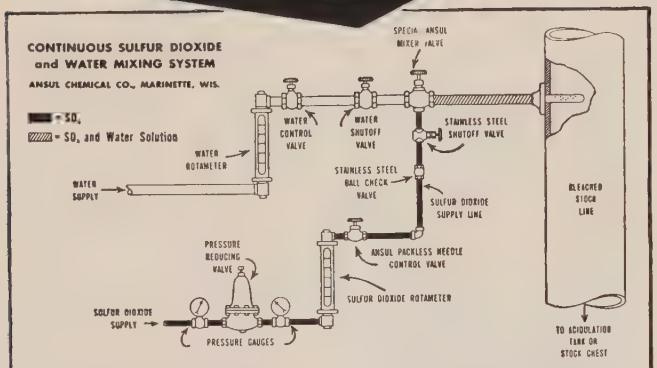

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4. Permits dissolving of organic lime compounds so they may be removed by washing.

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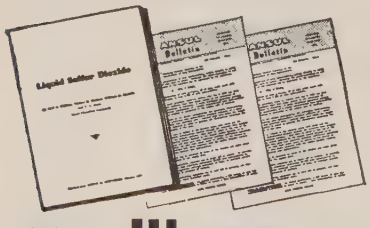

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The second gentleman of our panel is a graduate Chemical and Mechanical Engineer. His education was obtained in Sweden and Germany. His cosmopolitan background is indicated by experience in mills in Sweden, Germany, and France. He came to this country in 1925 and was directly connected with the Richardson Co. in Lockland, Ohio. He also worked for the Gardner-Richardson Co. of Middletown and Lockland, Ohio; Peter J. Schweitzer, Inc. of Elizabeth, N. J.; and W. C. Hamilton and Sons of Miquon, Pa. Therefore, it is a pleasure to introduce to you, Thage Dahlgren of the Pioneer Chemical Works of Philadelphia.

A man from Wisconsin is our next panel member. He attended Lawrence College in Appleton, Wis. and was graduated from the University of Michigan with the degree of Bachelor of Science in Chemical Engineering in 1930. Then he was first employed by Paper Makers Chemical Corp. in Kalamazoo, Mich. as research chemist. When this company was absorbed by Hercules Powder Co., he continued with Hercules at Kalamazoo until 1942, serving in the capacities of Chief Chemist and Technical Service Engineer. During the war he was engaged in TNT production at the Hercules operated Volunteer Ordnance Works, Chattanooga, Tenn. Since that time he has been with Hercules at Wilmington as Technical Service Representative, CMC Sales Supervisor, and in Technical Sales. About April 1 he is being transferred to Kalamazoo to be employed as Director of Technical Service Laboratory and a Service Representative Training Program. He will also act as a technical advisor to midwestern sales offices. With great pleasure I give you Mr. Henry Heller.

The fourth member of our panel graduated from the University of New Hampshire in 1928 and was employed for the next sixteen years by The Brown Co. in their plants at Berlin and Cascade, N. H. and LaTuque, Quebec. While with the Brown Co., he worked in the Research Laboratory, Physical Testing Laboratory, Paper and Pulp Inspection Dept., Paper Development Dept., Cost Accounting Dept., and lastly, in the Pulp Sales Division handling Specialty Items. He joined the American Cyanamid Co. in February of 1945 as the Technical Sales Representative of the Paper Chemicals Dept. for the Philadelphia District Office. Though I do not know the gentleman well enough to state the next phrase as my own, I will just quote the statement that he gave me, 'I'm just a D--n Yankee who left God's country to follow a preferred vocation.' May I present to you, Mr. George Lord.

Lloyd W. Carpenter, E. W. Twitchell, Inc.: What is the best practical method of testing kraft papers in the mill for sizing? Say 16-lb., bleached or unbleached.

Mr. Lord: It depends on the end-use of the paper.

Mr. Carpenter: Multiwall bag or twisting.

Mr. Lord: Suggest flotation on water according to Standard TAPPI method or Cobb Test.

Mr. Carpenter: How about ink flotation, is it a good test?

Mr. Lord: No, rather the TAPPI Standard Method.

Mr. Heller: It must be known to what use the sheet is to be put.

Mr. Carpenter: 16-lb. kraft for twisting.

Mr. Heller: The testing method depends on the bath through which the paper passes before entering the twisting dies. If it involves the penetration of an aqueous medium neither the TAPPI Dry Indicator Test nor the ink flotation test would be of much value. Perhaps, a true transudation test as the Fluorescence Size Test or the Reflectance Test developed by Hercules Powder Co. would be useful. Possibly, an immersion test which measures weight pickup would be suitable.

Mr. Haug: Colored papers must be considered which would cover the indicators.

Dr. Wilson: I would like to expand on what the various tests might mean. In measuring the transudation rate, it is the time that the first particle gets through. Whereas, with determination of the equivalent water pickup will give an idea of how much water a sheet will pick up. On the other hand, the equivalent water pickup of the sheet with the hardest rosin sizing will be about 50% that of an unsized sheet. This value does not correlate with rosin content. The wet break test correlates with an increase in rosin content. Much trouble comes in using these methods because the operators don't know what they are measuring. There is no sense in different end-points, for example, it might be that a sugar dye indicator would measure the first three particles to pass the sheet, fluorescent test would measure the rate for two particles and a more sensitive method might measure the rate for one particle. These are measuring rate only, not amount of pickup nor the full amount to be allowed passage through the sheet. The sheet is not saturated at the time of water penetration.

Mr. Haug: In measuring the rate the results will not correspond at all, necessarily, with water penetration.

Dr. Wilson: It depends on the hydrophobicity of the surface, the size of the holes in the sheet. Calendering will improve the water rate sizing tests but other tests get worse. Beating increases these tests but other tests decrease as demonstrated on the Noble and Wood Sheet Maker.

Mr. Dahlgren: I suggest one of the water drop tests such as used in the board industry. The rate of absorption and the angle of contact can be observed.

Dr. Wilson: This is a good indication of sizing, but has limitations.

Edw. A. Shallcross, Sharples Chemical Co.: Maybe he is interested in other sizing characteristics such as the stiffening effect of casein. In casein coating with good rosin sizing the casein is held on the surface and the pickup is less.

Mr. Lord: In old times twisting grades were water-leaf sheets. A simple toweling test for absorption or a volumetric test of absorption rate for 1 cc. with end point determined by lack of reflection.

Mr. Carpenter: Not now, twisting is hard-sized against water.

Mr. Heller: I wish to correct a statement which may have given an erroneous impression. The fluorescence test depends on a definite concentration of dissolved dye on the surface before the end-point is reached. It does, however, measure the rate of water transudation and not the total absorption.

Mr. Dahlgren: Since twisting papers are hard-sized, I suggest a modification of the Cobb test using a shorter exposure time. This would tell if sizing is uniform.

Mr. Carpenter: How is the testing done in the old country?

Mr. Dahlgren: It has been a long time, but as I remember it the drop method was used. The amount of spread and rate of penetration will quickly show what degree of sizing has been obtained. Water colored with dyestuff was used.

Mr. Carpenter: Like an ink.

Mr. Dahlgren: Suggest that the paper be over-sized and then the size cut back as experience is gained on amount required.

Dr. Wilson: In making twine with twisting paper the sheet is sized for strength against water softening over a length of time. Probably looking for increase in wet-strength from 30 minutes to an hour.

Mr. Carpenter: Onion bags, this type may be used for vegetables stored in the fields and may become wet for hours.

Dr. Wilson: Thus the exposure time may be 10 or 15 times that for any practical control test.

Richard S. Mooney, Scott Paper Co.: How do you go about sizing a carbonate filled sheet?

Mr. Dahlgren: I am not promoting a product, we do not sell size. Dr. Kress and Mr. Johnson of the Institute of Paper Chemistry proposed the presizing of calcium carbonate itself before adding it to the beater.

Mr. Heller: I have a few comments. Use wax, if possible, but if other requirements will not permit application of wax, use rosin size and arrange to add alum at the last possible instant. Sizing may be accomplished by lowering the pH only for an instant at the critical time. The full sizing effect which would be obtained in the absence of carbonate will not be realized, but results have been remarkable if alum is added at the screen discharge or even at the machine head box. More than the normal alum furnish is required, but the amount is not greatly excessive.

Mr. Dahlgren: What pH?

Mr. Heller: A pH of 5.0–5.5 in the tray water, of a transitory nature.

Mr. Lord: It can be done, but why do it? If you want more filler, use clay.

Mr. Heller: In board mills the carbonate filled furnish may be the cheapest furnish which will give adequate brightness. Much low cost board must be fairly hard sized.

Dr. Wilson: I don't know wax sizing, but it is the only size that will give decent results on a carbonate filled sheet. Ammonia has a pH of about 9 whereas calcium carbonate is 8.0.

Mr. Heller: I have seen it work, but sometimes the carbonate will kill the sizing after the sheet is formed. Possibly, the need for sizing in the end-use will have been passed by that time.

Mr. Dahlgren: In the board industry the carbonate is eliminated with acid or alum, practically, if the concentration of calcium carbonate is not too high. Dr. Kress' and Mr. Johnson's suggestion to size the filler might work. There is a possibility that the sizing in contact with carbonate will be lost in a few days.

Dr. John P. Weidner, Container Corporation of America: Is it possible to get sizing that will last any length of time if the alum can be made to act in a short length of time to stick rosin on fiber or filler?

Mr. Heller: There can be too short a reaction time between the alum and the size, but board has been produced which remained fairly hard-sized until the customer was satisfied. Complete decomposition of the carbonate is uneconomical as some furnishes may contain as high as 25% carbonate.

Mr. Dahlgren: In times past the board mills have used hard shavings with smaller percentages of soft (carbonate filled) shavings and they are obtaining satisfactory sizing.

Mr. Heller: I had an interesting experience in the Midwest with soft shavings. The board was not being sized sufficiently with the regular procedure because of the pH which was brought down below 5.0 in the beater but it did not stay down in the vats. I asked that one beater of stock be set aside to demonstrate what

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was happening. This 1600-pound beater took 965 pounds of alum before the pH would stay down.

Howard Wright, W. C. Hamilton & Sons: What are the mechanics of setting rosin sizes as against setting combinations of wax-rosin sizes? What happens to rosin size in the beaters?

Dr. Wilson: I have wondered about that question myself. In investigations on V-Board under the microscope rosin particles of about 1 micron were observed in the presence of pulp fibers. There was much Brownian movement and the size particles paid no attention to the fiber. Upon addition of alum they were immediately attracted to the fibers and made immobile. There is no reason to believe that there is any difference in the beater except that in the beater all the furnish is in turbulent motion and the aluminum ion can't hold the size on the fiber until the system becomes quiescent.

Mr. Wright: Does the coverage approach a continuous film?

Dr. Wilson: You don't need a continuous film. Small rosin particles could go through holes in the fibers if ultramicroscopic or between the fibers, but rosin is larger than the holes and, consequently, engine sizing is only on the surface.

Mr. Lord: You mentioned rosin size combinations?

Mr. Wright: There are limitations on the amount of sizing possible with rosin size alone, what are they?

Mr. Lord: The maximum effect is obtained with about 2.5% rosin. Wax sizing will increase the internal sizing of the sheet.

Mr. Wright: How much wax sizing may be added without increasing the surface lubrication?

Mr. Lord: 0.1 to 0.2% wax emulsion will give twice as much sizing, the trouble being that application is limited by some factors. It will lubricate the fibers if used in excess.

Mr. Heller: I do not wish to sound frivolous but we of Hercules Powder Co. wish we knew the answer to the mechanics of rosin sizing. There is a good job waiting for anyone who does know and can prove that he knows. Work on sized paper being conducted with the use of the electron microscope is developing some useful information. We think we can tell the difference in appearance between good and poor sizing but we are not sure, yet.

J. F. Kirk, General Chemical Division, Allied Chemical and Dye Corp.: I wish to ask Dr. Wilson about the mechanics of the aluminum ion. Is the action chemical or physical?

Dr. Wilson: I believe it is a plain ion exchange. The carboxyl unit is replaced with the aluminum ion. The same as coagulation of ions to form water. The same thing occurs in paper making with the added effect of the aluminum floc.

Mr. Mooney: Why isn't the tetra-valent stannic ion as good as trivalent aluminum ion, then?

Dr. Wilson: Two things. (1.) We are measuring the result, not the number of ions absorbed of the trivalent metal. (2.) The ionization constant as well as concentration enters into the picture. It is possible to exceed that of aluminum sulphate and get excess total acidity.

Donald Bradner, E. I. du Pont de Nemours and Co.: Which has the greater surface selectivity, does the aluminum ion prefer the fiber or the rosin.

Dr. Wilson: It can be put on either or in combination on both. A charge can be put on without ionization. Colloidal size of rosin is important, practically, if ionized only.

Anthony J. Wirpsa, E. F. Houghton and Co.: Why is wood rosin no good and gum rosin good for size making?

Mr. Dahlgren: During the war I used both and can't see much difference.

Mr. Wirpsa: My experience resulted in using nearly twice as much wood rosin.

Mr. Dahlgren: Maybe you got freshly prepared wood rosin.

Mr. Lord: The difference is a figment of the imagination rather than a true story of the problem. In some instances wood rosin is better. Considerations include the free rosin content and water conditions.

Mr. Wirpsa: The free rosin was held at the same level.

Mr. Heller: It so happens that Mr. Wirpsa's experience was with our size but we have no explanation. In say, 2% of the cases either may be better, in 98% they will have the same efficiency.

Mr. Dahlgren: My first experience resulted in more foam. I do not believe that there is a difference in the results. If wood rosin is made right as good results can be obtained as with gum rosin. Foam has a tendency to spoil sizing to some degree.

Dr. Wilson: I am an ex-alum manufacturer. Hercules tells us that there are a large number of acids in rosin but I believe that alum water proofing is more important than that from acids might be present. Or the formation of aluminum-rosinate. Ordinarily the angle of contact of sized paper is from 60 to 70°. Different aluminum salts of different acids might have different angles of contact.

Mr. Heller: We have seen no more differences between gum and wood rosin in closed systems than in open systems.

H. L. Becher, Homosote Co.: What effect does pH have?

Mr. Lord: pH is secondary. Paper may be hard sized at pH of 6.0 or 4.0. If permanence is required of the paper use 6.0. Excessive alum is often used as a cure-all.

Dr. Wilson: If I were to operate a paper mill I would want a pH machine but the instrument has been terribly oversold in the paper industry. If there is any aluminum ion in solution and an ionic exchange takes place, as on the formation of sodium sulphate the pH goes up. The sulphate radical attached to the alum complex results in increased alkalinity of the white water and increased acidity of the paper. Operators must have a knowledge and the judgment to use this knowledge to successfully size paper.

Mr. Dahlgren: The total acidity must be taken into consideration.

J. Wayne Dappen, Scott Paper Co.: Using water with a high pH and alum and sulphuric acid to lower the pH, what should the ratio of sulphuric acid to aluminum be?

Mr. Lord: It depends on the water. I would suggest starting with three parts of alum to one part of acid.

Dr. Wilson: If you are sizing you want the presence of the aluminum ions, you may get the pH down before enough alum is present. For example, the pH will come down with a small amount of alum if the hydrogen ion forms on the pulp.

Mr. Heller: Dr. Wilson, what is the minimum quantity of alum needed?

Dr. Wilson: A guess, based on experience with Nobel and Wood Sheet equipment is that 6% alum on the fiber will give the maximum effect.

Mr. Heller: How much alum based on the weight of dry size?

Dr. Wilson: It is possible to add enough size to nullify sizing effect.

Mr. Heller: It takes $^1/_3$ pound of alum to neutralize 1 pound of a normal grade size, but 2 to 3 times this quantity is, ordinarily, required to obtain optimum sizing. However, excessive alum is not only wasteful, but harmful to sizing.

Mr. Dahlgren: Why is 1.2 to 1.5 times the amount of alum used for each pound of dry size, generally?

Dr. Wilson: You have to get the alum in.

Allan Schenck, Riegel Paper Corp.: What is the fixed ratio of aluminum ion desirable? What optimum pH?

Mr. Heller: I don't pretend to know the theory as well as Dr. Wilson. The practical minimum amount with a normal pulp furnish is $^3/_4$ lb. of alum to 1 pound dry size. You can't get by with much less. This figure is well below the average for the paper industry. The pH depends on type of fiber and varies considerably. A pH of 6.0 may work well with one fiber and be unsatisfactory for another. Kraft may be sized at a higher pH than sulphite or groundwood.

Mr. Lord: Alum is used in excess, even though I sell alum, I would rather see it used more scientifically and eliminate some of the headaches resulting from overuse.

Mr. Haug: Then the minimum is $^3/_4$ pound alum to 1 pound of dry size.

Mr. Heller: Right, in my experience.

Joseph Paciello, E. I. du Pont de Nemours and Co.: The optimum pH of 6.0 being good, what happens when it is brought back to this figure with soda ash or sodium aluminate?

Mr. Heller: That depends on how long the stock is maintained at the higher pH. I would suggest raising the pH at the fan pump or someplace near the machine rather than in the beater.

John Bainbridge, Monsanto Chemical Co.: What is the optimum pH before addition of rosin size and why?

Mr. Lord: There is no such thing. Start on the alkaline side just over neutral if there is a choice.

Mr. Heller: We won't go along with that.

Dr. Wilson: In the question of lowering or raising pH, it is better when taken down to 4.0. The white water system usually extends over a large area and involves large volumes on a paper machine and may affect the action. On the Noble and Wood Sheet Machine, the alum ion can get its work in faster than you can. With a pH drop there will be a sizing drop.

Mr. Heller: When the pH is taken down to 4.5 with alum before the addition of size, the sizing is excellent, but when taken down with sulphuric or hydrochloric acids to the same pH there will be sizing trouble. There is no advantage in sizing to be gained by lowering the initial stock pH below about 6.0.

Mr. Wright: This depends on mill and white water conditions. You must know the total acidity of the white water and use it as a guide.

Mr. Haug: Each mill has its individual problems.

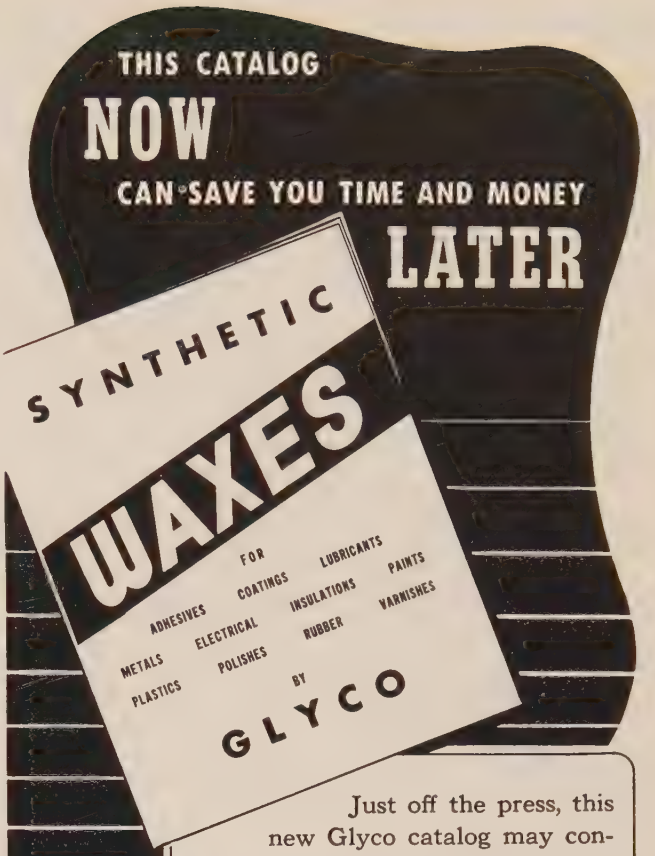
Mr. Heller: It depends on what brings the initial pH down.

Mr. Wright: It is a fallacy to have too much attention paid to pH; there is not enough attention to total acidity. It is advisable to adjust pH to suit conditions.

William V. Kane, Scott Paper Co.: Instances of cases popping open after the sealer have occurred upon aging. Could this be a difference in the sizing or pH of the Top and Back Liners? What test method might be used to determine this?

Mr. Lord: Suggest the Cobb test and an additive to the adhesive used to get proper strike through of the adhesive.

Mr. Dahlgren: This might happen if, as usual, the top liner is hardsized and the back liner is relatively unsized. There might have been too much or too little water in the paste. A change in



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the adhesive might be indicated or have occurred. I suggest that specifications be adjusted to suit your applications. Sheet formation may have a bearing on this problem.

K. W. Britt, Scott Paper Co.: In the question of carboxyl groups bonding with aluminum ions, Dr. Wilson, using 1.2 to 6.0% alum, this adds up to too many carboxyl groups.

Dr. Wilson: No, no more than 15% of the alum is used on the carboxyl groups. An ionization of 20% is tops.

Mr. Britt: Then the alum is not all active?

Dr. Wilson: The aluminum is originally present as the ion.

Mr. Britt: There is only a small portion present?

Dr. Wilson: 3.7% of the carboxyl groups are present on the surface. Only those on the surface are active.

Mr. Britt: Then it is not possible for a large part of those present to bond.

Dr. Wilson: Only those that can come in contact may bond.

Frank J. Lovegren, W. C. Hamilton and Sons: I would like to hear a little more about the difference in pH of the white water and the extracted pH value for a given sheet.

Mr. Lord: It can be all over the lot.

Mr. Wilson: The hydrolysis of the alum, especially, in a hot extraction may make the two values differ widely.

Donald H. Newcomb, Riegel Paper Corp.: How does the alum concentration affect sizing?

Dr. Wilson: The absorption isotherm for different concentrations of alum is quite different.

Mr. Wright: How does the length of time of contact and treatment affect sizing?

Mr. Heller: The time of contact between the size and the fiber does not affect sizing, before alum addition, provided the agitation is sufficient.

Mr. Wright: Does extra beating cause hydroxyl ions to present additional surfaces for possible contact?

Mr. Lord: Put the rosin in early, alum in late.

Mr. Wright: I don't hold with the theory of hydration but believe that fibrillation, etc. is more important.

Dr. August S. Erspamer, P. H. Glatfelter Co.: It is a question of amount of refining, not amount of time.

Mr. Heller: Is sizing improved with more highly refined stock? Let me think about it.

Mr. Lord: Better sizing results with rosin ahead of refining.

Mr. Dahlgren: Should not be added during refining, but after if agitation is ample. I have tried it with better results but don't know why.

Dr. Wilson: He hasn't read my last paper or doesn't believe it. A magnetized piano wire will not hold an iron cannon ball, where the same wire snarled up into a nest will hold the ball if either is magnetized. With rosin it is harder for it to make contact if refined.

Mr. Heller: On checking with practical experience, this ties in with the theory of an optimum particle size. With highly refined stock better sizing is obtained with larger size particles.

Dr. Wilson: It is a question of filtration and contact in combination.

Mr. Carpenter: Wouldn't refining give more exposed area? Better sizing?

Dr. Wilson: Wrong, except for water penetration which goes up with refining time, while other sizing tests go down. Our ink penetration went down as paper stock is refined further.

Mr. Haug thanked the panel members for the audience and the meeting adjourned.

FRANK J. LOVEGREN, *Secretary*

Kalamazoo Valley

The Kalamazoo Valley Section met on February 2 at the Columbia Hotel in Kalamazoo. Dinner was at 6:30 followed by a talk on Biological and Pest Control in the Paper Industry by Richard W. Kingerly of the E. I. du Pont de Nemours and Co. Development Laboratories, which was arranged by Fred Chapell of Hercules Powder Co.

Dr. Kingerly stated that most paper was sterile after coming out of digesters, and off the paper machines. This is no doubt due to the use of chemical toxicants such as hypochlorite, and peroxide bleaches as well as strong alkalies in the cooks.

Paper machine drying seems to kill the nonspore-forming variety of bacteria and allows many spore-forming varieties to survive. Since most disease causing bacteria are nonspore forming, the average sheet of paper off the paper machine is satisfactory for human handling.

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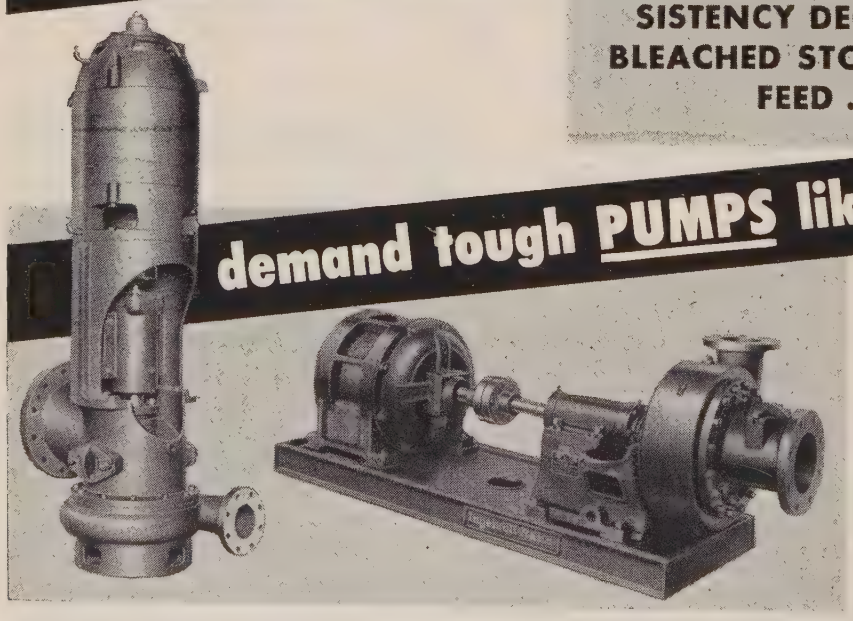

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usually sterile, then the fungi and slime forming bacteria must come from outside sources. These may be listed as water supplies, some air-borne bacteria, starches and gums, waste papers and broke. The reason for large build ups in many cases is due to the tendency to close system up and recirculate machine white waters.

For these reasons fungicides and bactericides are finding considerable usages in the paper industry. The purpose of toxicants in white water systems is to control the rate of growth of the bacteria and not to sterilize.

The present toxicants on the market can be classed as phenols, chlorinated phenols, and mercurials, or mixture of the above. Dr. Kingerly was of the opinion that the mercurials had a better inhibiting factor than the chlorophenols. He also stated that there is some disagreement regarding the use of mixtures of toxicants since it seems possible that a bacteria can develop resistance to more than one toxicant at a time.

Toxicants may be added continuously or in slug doses. The dosage and method is best determined for individual cases. Slime samples should preferably be checked on the spot or if sent away should be refrigerated to keep changes from taking place.

In regard to the hazards of using mercurials, a mercury content of 5 p.p.m. on the weight of the paper is not considered hazardous and a mercurial such as ethyl mercury phosphate reduces to approximately 20% of the beater feed in the finished paper.

As far as rodents, and insects are concerned, not much has been found for use that may be applied to food wrappers, although such things as methoxychlor are being evaluated. For nonfood wrap such things as D.D.T. and sodium pentachlorphenate are useable.

Following the talk a panel consisting of G. F. Des Autels, K.V.P.; Harold Wiles, Sutherland Paper Co.; J. J. Harrison, Michigan Carton Co.; H. R. Hall, Allied Paper Mills; and Mr. Placzankis, E. I. du Pont de Nemours answered questions on uses of toxicants and specific applications.

James Harrison, vice-chairman of the Kalamazoo Section announced that Harold W. Bialkowsky, Director of Research, Pulp Division, Weyerhauser Timber Co., would be the speaker at the March 2 meeting and would talk on "Pulps—How They Affect the Converter."

Graphic Arts Meeting

The Graphic Arts Day session, sponsored jointly by the Kalamazoo Valley Section of TAPPI and the Michigan Division of the Superintendents Association, will be held on April 6, 1950 at the Hotel Harris in Kalamazoo.

The following is a schedule of the meeting:

10:30 a.m.–12:00—Open house at the new Western Michigan College Pulp and Paper School.
No planned Luncheon.
2:00 p.m. at Hotel Harris—Papers.
1. Xerography and Xerographic Printing by Thomas Liston of the Haloid Co.
2. Gravure's Place in the Graphic Arts Industry by Joe Martin of the Champlain Co.
3. Developments in the Printing Ink Industry by Milton Zucker of the International Printing Ink Co.
6:30 p.m.—Dinner at Hotel Harris, followed by Robert H. Simmons, Associate Chemist, U. S. Gov't Printing Office, who will speak on Printers' Paper Troubles, and with Norman Bearce of Champion International Printing Office acting as toastmaster.

J. R. Dam, *Secretary*

New England

The New England Section of TAPPI held its January meeting on the 20th at the Hotel Northampton, Northampton, Mass. Robert H. Mosher conducted the meeting

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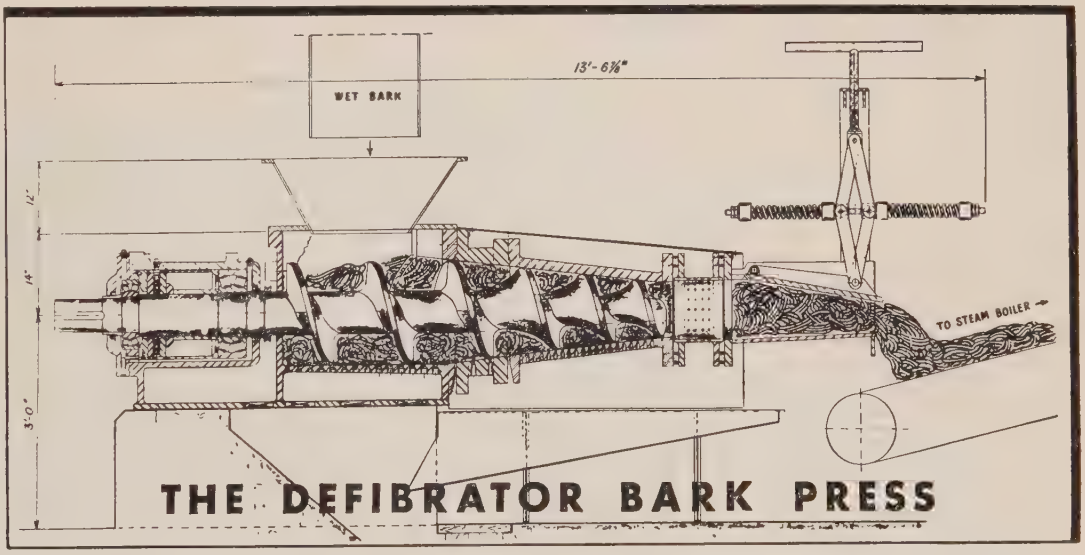

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which was devoted to paper lamination. The various aspects of this problem; namely, machinery, theory of adhesion, and the aspects of technical service were developed by a panel of five speakers. One hundred twenty people were in attendance.

The first speaker, Lawrence W. Egan of Frank W. Egan & Co., discussed "Machinery for Laminating Paper and Paper Board." Mr. Egan extemporaneously discussed various types of laminators for various types of laminations.

Frank C. Campins of Polymer Industries, Inc. discussed "The Theory of Adhesives." He stressed the importance of greater laminating speeds and higher quality. Thin adhesive films are important for the attainment of rapid set. Adhesives must wet the surface to be laminated. In general, wax cannot be tolerated on the materials to be laminated. Acetate laminations require that raw stock be grease resistant rather than water resistant. There can be little doubt that the adhesive must be a film former and this, to a certain extent, is dependent on the raw stock. Dr. Campins closed with the advice that perhaps orientation of conditions is one of the most important factors in the success of lamination. "Make conditions work for you—not against you."

Al Berk of Paisley Products, Inc. discussed "Water Soluble Specialty Paper Laminants." This embraced starch, casein, and animal glue.

"Special Adhesives for Film and Foil Laminations" was discussed by William Sederlund of National Adhesives Div. of National Starch Products, Inc. The differences between paper and film and foil laminations were cited. Water and solvent are absorbed by papers being laminated, but not in the case of films and foils. Adhesives are applied to only one stock, followed by drying and then lamination in a nip. Hot melts are generally used for moisture vaporproof laminations.

Herbert Wells of American Resinous Chemicals Co. read a paper prepared by J. J. Austin of Austin Industries. The title of the paper was "Information Necessary for Technical Service on Adhesives."

Chicago

As a summary report of the meetings we have held since last summer, we offer the following:

The Chicago Section of TAPPI, opened its 1949–50 season in September, with a meeting on "Plastic Printing Plates." E. M. Paulsen of Plastic Printing Plates, Inc., was the speaker.

In October, a discussion of "Radio Active Isotopes and Their Applications to the Paper Industry," was led by L. W. Meade of Tracerlab, Inc.

In November, a film on folding carton stripping entitled, "Breaking the Bottleneck," was shown. In the same theme, a discussion of "Press Make-Ready of Printing Plates," was led by Burt Rike of the Lakeshore Electrotype Co.

For the December meeting, technical discussion was laid aside in favor of a Christmas Party.

To start the New Year, the January meeting was devoted to a discussion of research. A color film, "An Introduction to Research," was shown and H. A. Leedy, Director of the Armour Research Foundation, told the group about the general plan of their organization and the operation of the foundation since its inception.

GEORGE A. ZINKEL, *Chairman*

Empire State

Western New York Group

The regular monthly meeting of the Western New York Group took place Wednesday, February 8 at the Prospect House in Niagara Falls, N. Y. Approximately 50 members and guests attended the excellent meeting presided over by Joseph S. Reichert of the Du Pont Co., Niagara Falls, N. Y.

Dr. Reichert introduced Burgess Johnson, Life Scout, who spoke briefly on the 40th anniversary of the founding of the Boy Scouts of America. Jack Rudolph, of the Kimberly-Clark introduced the moderator for the panel discussion. Paul Kuhnel, Superintendent of Kimberly-Clark Paper Mill. Mr. Kuhnel introduced the members of the panel, who discussed paper machine felts.

Members of the panel included Howard Brown, Lockport Felt Co.; Larry Woodside, Albany Felt Co.; Irving Peters, F. C. Huyck & Sons; and Fred Parkinson, H. Waterbury & Sons.

Each member of the panel discussed some phase of felt making and felt usage in the paper industry. Following the brief presentation by members of the panel an open discussion was held on the uses of felts in paper mills.

J. J. Forsyth

Metropolitan Group

The regular meeting of the Metropolitan Group was held on Tuesday, January 10, at the Fraunces Tavern in New York City. W. C. Nusbaum of Tracerlab., Inc. Boston, was the main speaker. His topic was the "Use of Radioactive Isotopes in the Pulp and Paper Industry."

Radioactive isotopes are produced by the Atomic Energy Commission at Oak Ridge, Tenn. Only 3% of the total amount of such material released for civilian use is allotted to industry, while 97% is reserved for hospital use and university research.

The usefulness of these isotopes depends upon the same principles that led to the discovery and use of the atomic bomb. It was discovered some time ago, that the element, radium, is naturally radioactive. This means that every atom of radium is constantly undergoing a process of disintegration into

(*a.*) Alpha particles (an alpha particle is the nucleus of a helium atom and consists of 2 protons and 2 neutrons).

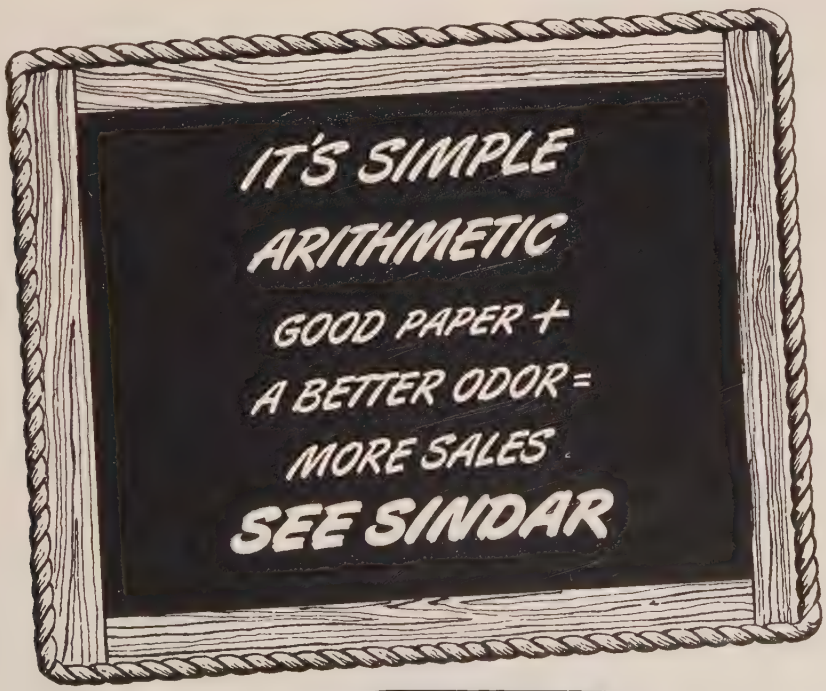
(*b.*) Beta particles (these are particles of negative electricity and are called electrons).

(*c.*) Gamma rays (these are electromagnetic waves or x rays).

This process of disintegration can neither be stopped nor accelerated. Eventually the atom of radium loses so many alpha and beta particles that it is no longer an atom of radium but is now an atom of lead. This is an example of the transmutation of elements. This new atom will have the atomic weight, 207, of Lead instead of the atomic weight, 226, of Radium. (It is interesting to note that not all of this loss in weight is recoverable in alpha and beta particles but that some of its weight or matter has been converted to atomic energy!)

It was later discovered that atoms which are not naturally radioactive can be made so artificially. It is these artificially radioactive atoms that are useful in industry. Their usefulness is due in part to the fact that the particles given off are easily detected. If an instrument called a Geiger Counter is placed in the vicinity of a radioactive atom, it will indicate that such an atom is nearby. The beta particles have great penetrating power and will pass through any material into space until it hits the instrument and indicates its presence. This flow of beta particles is called an electric current. If a galvanometer is placed so that this current will pass through it, the galvanometer needle will move. The degree of movement of the needle will depend upon the strength of the current. Radioactivity, therefore, can be detected and measured.

Ordinary atoms are not made radioactive but only special kinds of atoms. These special kinds are called "isotopes." An isotope is an atom of an element having a different atomic weight than the ordinary atom of that element. For example, an ordinary atom of Hydrogen has an atomic weight of 1 but there are also atoms of Hydrogen having an atomic weight of 2. Heavy water is heavier than ordinary water because it contains atoms of heavy hydrogen, atomic weight 2. For our work in the paper industry, an isotope of Carbon having



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an atomic weight of 13 is used. This Carbon 13 is an example of a radioactive isotope ready for use in the paper mill.

The most common use is on the Fourdrinier to detect variations in basis weight. The device that does this is called the Tracerlab Beta Ray Gauge. It also is used to test thickness of paper as well as of paper coating. Another novel use is to follow "tagged atoms" (otherwise known as isotopes) in the white water through a complete plant cycle. Stream pollution problems may also be attacked by the use of tagged atoms.

At the conclusion of his talk, Mr. Nusbaum exhibited the Tracerlab SM-3 Beta Gauge to an interested audience.

WILLIAM LANDES.

Hudson Valley Group

The Hudson Valley Group met at the Village Inn, South Glens Falls, N. Y. on Dec. 15, 1949. Walter S. Miller, Chief Fuels and Lubricants Engineer, Paper Mill Section, Gulf Oil Corp., Pittsburgh, Pa., was the principal speaker. His topic was "Drier Bearing Lubrication with Particular Reference to Circulating Systems Encountered in a Modern Paper Machines." Mr. Miller's remarks follow:

Lubrication is one of the most vital phases of paper machine maintenance, and uninterrupted production cannot be obtained unless efficient lubrication practices are observed.

In the old days of plain, open-cup bearings and open-bevel gear drives, the oiler was given a slab of suet, an oil can, and a pail of axle grease and told to go to it. Generally, the oiler was either a pensioner or someone considered not capable of handling anything else. No one paid any particular attention to him unless trouble developed. Generally, the oiler gave too much attention to those bearings easy to reach and the hard ones starved until they started to squeal.

As machine speeds and drier temperatures increased, improvements in bearings and gears were made and management became increasingly aware of the value and importance of proper lubrication. Today, it is common practice to have a crew of competent men, responsible directly to the Superintendent of Maintenance, applying high-grade lubricants in accordance with a well-planned lubrication program. They also work closely with the oil supplier's representative, who is generally an engineer experienced in the application of lubricants. Today, on high-speed paper machines the bearings and gears are totally enclosed and lubricated by a constant supply of fresh oil from a central circulating system.

It is not intended to give a history of the evolution of the paper machine, but rather, to point out some of the fundamentals of lubrication which are as applicable to old slow-speed machines as well as to modern high-speed machines with circulating systems.

In lubricating the roller bearings and gears on a paper machine, the primary consideration is to get an ample supply of fresh, clean oil to the bearings to insure an adequate oil film at all times between the rolling or sliding surfaces. There are several major points to be considered in the selection and maintenance of this oil:

Viscosity, stability, ability to effectively resist corrosion, and maintaining cleanliness of the oil.

Viscosity must be high enough to maintain adequate oil film between the contacting surfaces, yet low enough to flow through the piping in adequate quantities. Also, if the oil is too heavy, water and sediment will not settle out as rapidly as desirable. We have used, very successfully, an oil with a viscosity of 600 seconds at 100 °F., and there has been some consideration given to increasing this for higher temperatures.

Some recent developments in connection with roller bearing lubrication lead us to believe that viscosity is perhaps not as important as we once thought it was in providing an adequate oil film. At temperatures above 200 °F., there appears to be some other quality necessary to prevent the oil film from being rubbed or scraped away.

It should be noted that the lubrication of heavy duty roller bearings is not as simple as it would appear. Theoretically, roller bearings provide a true rolling motion on a perfect line contact between the rollers and races. Actually, due to the difference in diameter between the inner and outer races, and due to deformation of the races and rollers under load, this contact covers quite an area and some sliding action occurs. The constant flexing of the rolls and races will in time produce fatigue failure so if antifriction bearings don't last forever, don't always blame the lubricant.

Stability of the oil, or its resistance to oxidation, is an essential property of the oil in the system. Obviously, an oil of poor quality will oxidize in bearings and piping to an extent that free passage of the oil will be impeded. To provide proper lubrication to the bearings, the system must be kept as clean as possible, and we feel that this can best be accomplished by using an oil that will not form oxidation products in the first place, and that can be readily cleaned of paper dust, water and other contaminants by filtering, centrifuging and settling.

The importance of keeping the bearings and the systems clean cannot be stressed too much. From our observations, this is the most important single factor in obtaining satisfactory lubrication of paper machine dryer roll bearings. This applied equally to older type ring oiled bearings where the oil is subjected to even more severe conditions than in circulating systems, and cleanliness can be assured only by frequent flushing and changing.

Another important function of the oil is to prevent corrosion in bearings and piping. As you all know, the atmosphere surrounding a paper machine is extremely humid, and slight changes in temperature will cause condensation in bearing housings, piping, etc.

To prevent corrosion from the action of the moist atmosphere and condensation, the oil must possess additional "rust proofing" qualities not inherent in mineral oils. Generally, an "oiliness" additive, which imparts to the oil a preferential wetting ability, has proved very satisfactory, and such additives are incorporated in almost all the oils recommended for paper machine use.

Lake Erie Papermaker's and Converter's Association

Two rather different subjects were discussed at the January 20 meeting of the Lake Erie Papermaker's and Converter's Association which was held in Cleveland at the Hickory Grill. H. G. Hays, Technical Consultant for the Greater Cleveland Safety Council and General Manager of the Ohio State Safety Council spoke on, "What Are Poor Safety Tools Costing You?" Mr. Hays showed that the paper industry's accident record is not good and that accidents are costing the industry much more than the "direct costs" would indicate. He pointed out that if other forms of waste were as expensive as accidents, an all out effort would be made to reduce the waste. The money spent on accident prevention can result in a tremendous reduction in costs.

H. P. Ferguson and M. S. Obenauff of the Refining Control Division of the Standard Oil Company of Indiana collaborated in the preparation of the paper, "The Future Relation Between the Petroleum and Paper Industries." Mr. Ferguson delivered the paper which covered the lubrication requirements of a paper mill. Mr. Ferguson also talked about waxes, since the paper industry is the largest single user of wax.

The subjects for future meetings were announced as follows:

February—Labor-Management Relations by S. A. Stephens, Int'l 2nd Vice-Pres., Int'l Brotherhood Pulp, Sulphite and Paper Mill Workers.
March—Adhesives.
April—Taste and Odor in Paper.
May—Printing Inks.

The meetings of this group are held on the third Friday of every month at the Hickory Grill in Cleveland, Ohio.

Pacific

Originally patterned after the TAPPI Fall Engineering Conferences, the annual engineering meeting of Pacific Section has become an important feature of this Section's varied activities. The meeting at Everett, Wash., Feb. 7, 1950, attracted an attendance of about 160 men for the afternoon and evening sessions. Arrangements for the affair were handled by O. K. Chapman, Weyerhaeuser Timber Co., Pulp Division, Everett, Wash., C. W. Cassell, Everett Pulp & Paper Co., Everett, Wash. was Program Chairman and presided at the afternoon technical meeting, a summary of which follows.

(1) "Neutral Grounding of Industrial Power Systems," by C. D. Ries, Forest Industries Specialist, General Electric Co., Seattle, Wash.

"Neutral-grounding methods have been developed to deal with the difficulties which often arise in the operation of ungrounded systems. These problems include: insulation failures due to transient overvoltages, safety hazards to personnel, simultaneous outages due to sustained overvoltages, difficulties in finding ground faults, and sometimes higher system investment. The salient difference between ungrounded and grounded systems is that, in the former case, the system neutral is maintained at ground potential only by distributed capacitance, in the latter case by a definite circuit from neutral to ground of known characteristics. By providing the proper impedance characteristics in this neutral circuit, the foregoing disadvantages may be avoided.

"Power system neutrals are grounded by several methods, such as (1) solid, (2) resistance, (3) reactance, (4) ground-fault neutralizer, and (5) combinations of these with special sensitive relays. Studies of such methods show that the preferred practice for industrial plants is: solid grounding for systems rated 600 volts and below, and resistance grounding for systems rated 2.4 to 13.8 kv. In the latter case, grounding resistors are selected to minimize the magnitude of ground-fault current and provide satisfactory relaying of ground faults.

"A ground bus system which insures low resistance between frames and enclosures of apparatus and the grounding point is more important than low resistance to earth. Particular attention should be given to the grounding of large portable electric machinery to insure safety to personnel."

(2) "Engineering Materials and Factors Influencing Their Selection," by L. M. Johnson, Resident Engineer, Soundview Pulp Co., Everett, Wash.

"The selection of an Engineering material for a specific purpose requires the careful evaluation of many factors, each of which has a definite bearing upon the final choice. In many instances the obvious or first choice may, after evaluation of the several influencing factors, be found inferior to other materials that can be either more or less expensive when comparing first cost. Economic aspects and obsolescence factors must be included in every study of an Engineering material. Maintenance and service costs required to enable a particular material to attain the Amortization period desired may serve to rule out those that often appear satisfactory in other respects. The weight given to the several influencing factors must be set up for the specific problem, and the relative order of importance will vary widely from one project to another.

"Relative costs of several representative materials are given, together with elementary economic studies for illustration. Material selection upon an 'accepted practice' basis without investigation of the influencing factors is not indicated in a majority of cases. The selection of a material may be simplified if the influencing factors are set forth and arranged according to their relative importance. The relative importance of the factors may change from one case to another, depending upon the nature of the work involved or the permanence required. Cost limitations that may be imposed by management frequently place this factor in the position of greatest importance and consideration, and on the other hand service conditions may dictate the choice of more expensive materials regardless of other factors.

"The following outline and arrangement of the factors covering the selection of a material for a purpose where more than one type is suitable for use are set forth, for example: (1) Suitability, (2) Relative Investment, (3) Maintenance and service requirements, (4) Estimated Service—Life vs. Obsolescence, (5) Economic Aspects, (6) Availability, (7) Workability, and (8) Replacement."

3. "Recent Developments in Burning Wet Wood," by Otto de Lorenzi, Director of Education Combustion Engineering-Superheater, Inc., New York, N. Y.

"The efficient, controlled combustion of wet wood waste, has been handicapped by the necessity for using two-stage furnaces comprising a dutch oven for drying and gasification, usually gravity-fed through the roof, and a secondary chamber in which combustion of gases is completed. These are characterized by high maintenance of refractories, need for frequent cleaning of stationary horizontal to sharply inclined grates, lack of predrying of wet hogged fuel or bark before it comes to rest on the fuel bed and difficulty in controlling rates and proportions of fuel and air supply.

"Recent developments include a very promising experimental unit with an 8 by 8-foot grate supplied with wet wood by underfeed. By this arrangement, all air supplied both below grates and overfire, and the fuel feed, are automatically controllable. This unit has developed up to 15,000 pounds of steam per hour with a CO_2 of about 18%, without economizer or air heater. The combustion chamber above the grate is about 20 feet high and is provided with water walls.

"A large midwestern paper mill has installed several steam-generating units to burn wet wood refuse and pulverized coal. These consist of a dutch oven located below a large water-cooled secondary combustion chamber in which the coal is burned.

"Spreader-stoker firing of wet wood in single stage water-cooled furnaces appears to provide a most satisfactory method, with automatic controls, high capacity per foot of furnace width and optional coal firing. Both absence of smoke and observation by colored motion pictures indicate that ample time is allowed for burning char particles. The major portion of the air is supplied undergrate, although overfire jets are used to produce turbulent mixing of the gas. Rapid burning makes for almost instantaneous response to load changes. Very slow chain grates are used for removal of any ash or sand accumulations.

"Another successful variation of the above design utilizes a spreader-type distributor located high above the chain grate

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and supplied from a live-bottom fuel bin. The fuel falls through four alternate tangential zones of preheated forced-draft secondary air. Underfire air is at room temperature and is supplied by induction through the chain grate.

"These boilers have been operated up to 120,000 pounds of steam per hour on naval stores 'spent chips.'

"Hogged fuel is normally fired at a moisture content of 45–65%, with pressing or separate flash-drying with flue gas necessary in the event the moisture is above 65%."

4. "Development Engineering in the Pulp and Paper Industry," by P. R. Sandwell, Consulting Engineer, Beecher and Sandwell, Seattle, Wash. and Vancouver, B. C.

"Careful planning is essential to the prompt and satisfactory solution of development problems. The engineer responsible must have a clear understanding of the problem, its background, and the management's objectives including time allotted and return expected.

"A thorough bibliographical search is always justified, as it usually eliminates the necessity for much preliminary work and makes available the previous findings of others to serve as a springboard for research applied to the particular local conditions which must be met. Similarly, broad knowledge of similar processes or equipment in current use in the trade is important. All local information having any bearing on the subject, including operating records, logs and charts, must be analyzed and interpreted by a qualified, imaginative development engineer.

"The value of conferences cannot be over-emphasized. These should include all interested management, operating and technical personnel whose combined knowledge will contribute to the study. The leader should follow a planned outline which will guide the group through the fact-gathering, boiling-down, discussion and planning stages, and should insist on a joint decision on the course of action before concluding his meeting. Complete stenographic records of the discussion should be made and distributed.

"Wherever definite design data are lacking, and cannot be calculated directly, recourse to analogous processes on which data are available, studies of small-scale models, and development on a laboratory or pilot-plant basis are valuable providing good judgment is used in extrapolating the results. At this stage, full justice must be given to the project, as indifferently-planned or executed trials can fail for reasons having little or no bearing on the main problem.

"At the conclusion of the technical meeting, the members were guests at a reception at the Monte Cristo Hotel which was sponsored by the host mills in Everett. Following dinner at the Monte Cristo, Pacific Section Chairman W. F. Holzer introduced Dean Harold E. Wessman of the College of Engineering, University of Washington.

"In his discussion of 'Straws in the Wind,' Dean Wessman criticized the trends in this country toward the development of a welfare state. He specifically opposed the proposed legislation now before Congress dealing with Columbia Basin Development whereby unprecedented power would be put into the hands of a three-man administrative board.

"From an engineering standpoint, Dean Wessman stated that an orderly development of the resources of the Columbia Basin is sound. However, he said, such a project should be undertaken by local interests in order to safeguard individual and state rights.

"The next meeting of Pacific Section is scheduled for April 7 at Camas, Wash. Harold C. Wall, Longview Fibre Co. and Past Chairman of the Section, will be in charge of the Annual Shibley Award Contest which constitutes the technical program for the meeting. At Camas the Section will be host to a group of students from the several Colleges and Universities in the Pacific Northwest."

R. M. True,
Secretary

OBITUARIES

William J. McCarthy

William J. McCarthy, Pressman, News Syndicate Co., New York, N. Y., died of a heart attack at his home in Astoria, N. Y., on Saturday, January 28, and was buried on February 1. Prior to joining the New York *Daily News* in 1931, Mr. McCarthy was superintendent of materials control for the Ford Motor Co. and sales manager for the Standard Body Corp. Although he was not directly connected with paper manufacture he had a deep interest in paper mill operations and spent entire vacation periods visiting mills. He was a regular attendant at the Canadian Technical Section and TAPPI meetings during which he made many friends in both organizations. He was an associate member of TAPPI. He is survived by his sister, Miss Margaret McCarthy of Astoria, N. Y.

John B. Venturini

John B. Venturini, sales representative for the Cameron Machine Co., Brooklyn, N. Y., died at his home in Dumont, N. J., on Saturday, February 4. Mr. Venturini was born in Hoboken, N. J., on April 19, 1883. He was associated with the Cameron Machine Co. since 1914 and represented them in Canada and New England for 30 years. Prior to going with Cameron he worked for the Dexter Folder Co. He is survived by his wife, Mrs. Eva Fitch Venturini, and a daughter, Mrs. Geniva Speed.

Merton Shumway Fogerty

Merton Shumway Fogerty, Chief Engineer of the Sutherland Paper Co., Kalamazoo, Mich., died suddenly on Wednesday, February 8. Mr. Fogerty was born in Worcester, Mass., on April 20, 1891, and graduated in 1913 from the Worcester Polytechnic Institute as a civil engineer. From 1914 to 1937 he was Chief Engineer of the Groveton Paper Co. From 1937 to 1944 he was Chief Engineer of the Michigan Paper Co. From 1944 to 1947 he was Vice-President and Chief Engineer of the Bryant Paper Co., now the St. Regis Paper Co. Since 1947 he was Chief Engineer of the Sutherland Paper Co. At the Fourth Engineering Conference of the Pulp and Paper Industry held in Boston in October, 1949, he was appointed Chairman of the Mill Maintenance and Materials Committee of the Technical Association of the Pulp and Paper Industry.

Portland Alkaline Pulping Session—Correction

R. H. Stevens, Technical Director, National Container Corp., Jacksonville, Fla., has advised us of the following error in the report of the Alkaline Pulping Session which was held at Portland, Ore.

On page 71A, second column, lines 14 and 15 of the January, 1950 issue of TAPPI, the words: "simple sulphide of iron and sulphur" should read "double sulphide of iron and sodium."

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Calendar of TAPPI Meetings

NATIONAL

Annual Meeting: Commodore Hotel, New York, N. Y., February 19–22, 1951.

Fundamental Research Conference: Chateau Frontenac, Quebec, P. Q., May 29–30, 1950. Symposium: "The Papermaking Properties of Fibers." (Joint Meeting with Technical Section, Canadian Pulp and Paper Association).

Fifth Engineering Conference of the Pulp and Paper Industry. Netherland Plaza Hotel, Cincinnati, Ohio, October 2–5, 1950.

Second Testing Division Conference. Eastman Kodak Co. plant, Rochester, N. Y., September 6–8, 1950.

Fibrous Agricultural Residues Conference, Peoria, Ill. (Date to be announced.)

LOCAL SECTIONS

PACIFIC SECTION:
April 7, 1950, Camas, Wash.

EMPIRE STATE SECTION:
Western New York Group:
April 12, 1950, Spaulding Fibre Co., Tonawanda, N. Y.
May 10, 1950, Prospect House, Niagara Falls, N. Y.
Metropolitan Group:
April 11, 1950, Fraunces Tavern, New York, N. Y.
Northern New York Group:
April 13, 1950, Woodruff Hotel, Watertown, N. Y.

DELAWARE VALLEY SECTION:
March 23, 1950, Engineers Club, Philadelphia, Pa.
April 27, 1950, Engineers Club, Philadelphia, Pa.

OHIO SECTION:
April 13, 1950, Manchester Hotel, Middletown, Ohio.
May 11, 1950, Manchester Hotel, Middletown, Ohio.

MAINE-NEW HAMPSHIRE SECTION:
June 23–24, 1950, Wentworth-by-the-Sea, Portsmouth, N. H.

KALAMAZOO VALLEY SECTION:
April 6, 1950, Harris Hotel, Kalamazoo, Mich.
May 4, 1950, Harris Hotel, Kalamazoo, Mich.

LAKE STATES SECTION:
April 11, 1950, American Legion Club House, Appleton, Wis.
May 9, 1950, Forest Products Laboratory Program.

LAKE ERIE PAPERMAKERS AND CONVERTERS ASSOC.:
April 21, 1950, Hickory Grille, Cleveland, Ohio
May 19, 1950, Hickory Grille, Cleveland, Ohio

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